5-2009

UMass Center for Exploration and Innovation in the Built Environment

Neal A. Overstrom
University of Massachusetts - Amherst, noverstrom@comcast.net

UMass Center for Exploration and Innovation

in the Built Environment

Master of Landscape Architecture Project

Department of Landscape Architecture and Regional Planning

University of Massachusetts, Amherst, MA 01003

Neal Overstrom May 2009

Approved by:

____

Elizabeth Brabec, Department Head

____

Michael Davidsohn, Chair

____

Mark Lindhult, Committee

____

William Mitchell, Committee

____

Jane Thurber, Committee

ACKNOWLEDGEMENTS

I thank the following people for their insight and assistance:

Jack Ahern/Landscape Architecture and Regional Planning

Annaliese Bischoff/Landscape Architecture and Regional Planning

Kyle Brown/John T. Lyle Center for Regenerative Studies

Kathleen Carroll/ UMass Extension, Agriculture & Landscape

Kevin Hartzell/Landscape Architecture and Regional Planning

Simi Hoque/Building Materials and Wood Technology

Niels La Cour/Facilities and Campus Planning

Joann Vieira/Tower Hill Botanical Garden

David Williams/The Williams Group

Sincere appreciation to my graduate project committee
for their continued support, guidance and good spirit:

Michael Davidsohn (Chair), Mark Lindhult, and Jane Thurber from
the Department of Landscape Architecture and Regional Planning
and William Mitchell from The Stockbridge School of Agriculture

Special thanks to my children

Nathan and Gretchen for their inspiration and to my wife

Sharon for her steadfast encouragement and for sharing the journey.

Sharon Overstrom

Space is the constant in all three
dimensional design, but it cannot be
realized until it is defined by materials
James Rose (1939)

This work was supported by a grant from the

Phi Kappa Phi National Honors Society, Baton Rouge, LA.

ABSTRACT

This project proposes the design of a studio facility on the University of Massachusetts campus dedicated to the exploration and application of both traditional landscape materials (earth, structure, plants, water) and contemporary technical media (infiltrators, irrigation systems, green-roof systems) as apart of an interdisciplinary learning landscape committed to sustainability in built environments. At no time in history has the appropriate choice and application of materials for use in the built landscape been more significant. Today the use of materials and techniques that mitigate and, where possible, reverse the impacts of environmental degradation is vital. This mandate notwithstanding, the importance of beauty and aesthetics as an integral element of human sustainability is argued by both landscape professionals and theoreticians. This facility will be unique among university learning environments in that it will foster the convergence of ecology and design by providing a venue for researcher innovation, student exploration and public exhibition related to landscape materials and the built environment.

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

A Green Campus

The first decade of the 21st century has seen the Earth's human population reach 6.7 billion, a number projected to increase to 9 billion by 2050 (United Nations Department of Economic and Social Affairs 2007). The environmental impact of adding more than 52 million people per year to the planet will be significant, particularly when most of the net gain will be in the urban areas of developing countries where economic growth and industrialization are already expanding. Since the mid-20th century we have seen pronounced and deleterious alterations to the Earth's ecological systems that support life. More than 50% (soon increasing to 70%) of all accessible fresh water is presently used by humans (Postel et al. 1996). One third to one half of the earth's surface has been transformed for human use and more nitrogen is fixed by humans than by all natural sources combined (Vitousek et al. 1997). All of these impacts, including changes in the abundance and distribution of other living species, can be related to the growing scale of human activities (Vitousek et al. 1997).

Today the problem of global sustainability is widely acknowledged as is the understanding that solutions are both urgently needed and difficult (Adams 2006). Institutions of higher learning clearly have key roles to play in this challenge, first and foremost with regard to curbing their own environmental effects. To this end University of Massachusetts Chancellor Robert C. Holub has created the following mandate:

"The University of Massachusetts Amherst recognizes that the fulfillment of its mission has a far reaching impact on the environment, including climate change. To insure that our campus is doing everything feasible to reduce its environmental footprint and become a more environmentally-responsible institution, I am charging the newly established Environmental Performance Advisory Committee (EPAC) with the following tasks:

Assess ways to reduce environmental impacts of the campus in a manner which incorporates sound business practices;

Enhance the campus' ability to gather, track, and analyze environmental performance data and related information and develop report documents;

Develop a 5 to 10 year plan to reduce the campus' carbon footprint based upon current benchmarks;

Devise a comprehensive and common-sense way to foster environmental stewardship across the entire organization among and within campus departments, both operational and academic; and

Advise the Chancellor's Executive Board on all matters related to campus environmental performance including adjustments to operating policies and/or practices."[1]

In addition to these mandates for implementing environmentally sound practices on campus --and in the tradition of public education and outreach as a land grant and cooperative extension college -- the University of Massachusetts has the opportunity to take a leadership role in promoting sustainable design and construction beyond the its institutional boundaries. In recent years the University has made

1 www.umass.edu/epac/EPAC.htm

impressive advances in environmental stewardship through major investments in energy infrastructure, green building construction, recycling and solid waste management and water reclamation. These capital and operational improvements have value well beyond fulfillment of the University's obligations to reduce its environmental impact. They can serve both as a showcase for the innovative materials and technologies at the heart of these strategies and as a springboard for their advancement and broader application in the built landscape through research, formal and informal programming, and public outreach.

A Learning Landscape

Faculty and administrators of the University of Massachusetts' Department of Landscape Architecture and Regional Planning and The Stockbridge School of Agriculture have long discussed the value of an applied technology learning center where students could undertake large-scale modeling of landscape interventions using both traditional and contemporary landscape construction materials (Davidsohn 2009 per. comm.). In the past students have gained such experience by undertaking planting, paving, and other landscape improvements at locations on and off campus, however the ability to expose them to a consistent assemblage of material sets and construction techniques under controlled conditions has been lacking. The logistical requirements for doing so would include having areas for material storage, access to large volumes of flowing water (for stormwater management exercises), and the equipment needed to safely handle bulky landscape materials, all in a space made habitable throughout the academic year.

The concept of providing hands-on learning opportunities for students of landscape architecture and related disciplines is not new. The merits of design/build teaching as a way of familiarizing students with the nature of construction materials and how they behave in real-world settings have been demonstrated not only at the University of Massachusetts, but also notably in the landscape architecture program at the University of Washington (Winterbottom 2002), and the architecture programs at Auburn University (Hinson 2007) and Yale University (Hayes and Stern 2007). Moreover, design/build as a way of shaping students thinking about the overall design experience has also been recognized (e.g., see Carpenter 1997 for a history of construction education in architecture and other case studies). However there are few examples in the literature of learning settings where students can undertake construction exercises in a large scale studio setting, allowing them either individually or in groups to design and construct their own projects according to predetermined curriculum goals. The resources of such a facility would be of value not only to students, but researchers, landscape and design professionals, and informal education audiences as well, anyone interested in modelling or testing field installations under controlled conditions.

The groundwork for siting a facility dedicated to the formal and informal study of landscape materials and a sustainable built environment has been completed in the University of Massachusetts planning exercises of the 1990s (Figure 4.1). In August 1993 the University published a physical masterplan for the Amherst campus authored by the Department of Landscape Architecture and Regional Planning (LARP) faculty and University officials (Ahern et al. 1993). In subsequent years more detailed plans were published for individual areas identified in the masterplan (Lindhult and Ahern 1995a, 1995b, 1997, 1998). Each

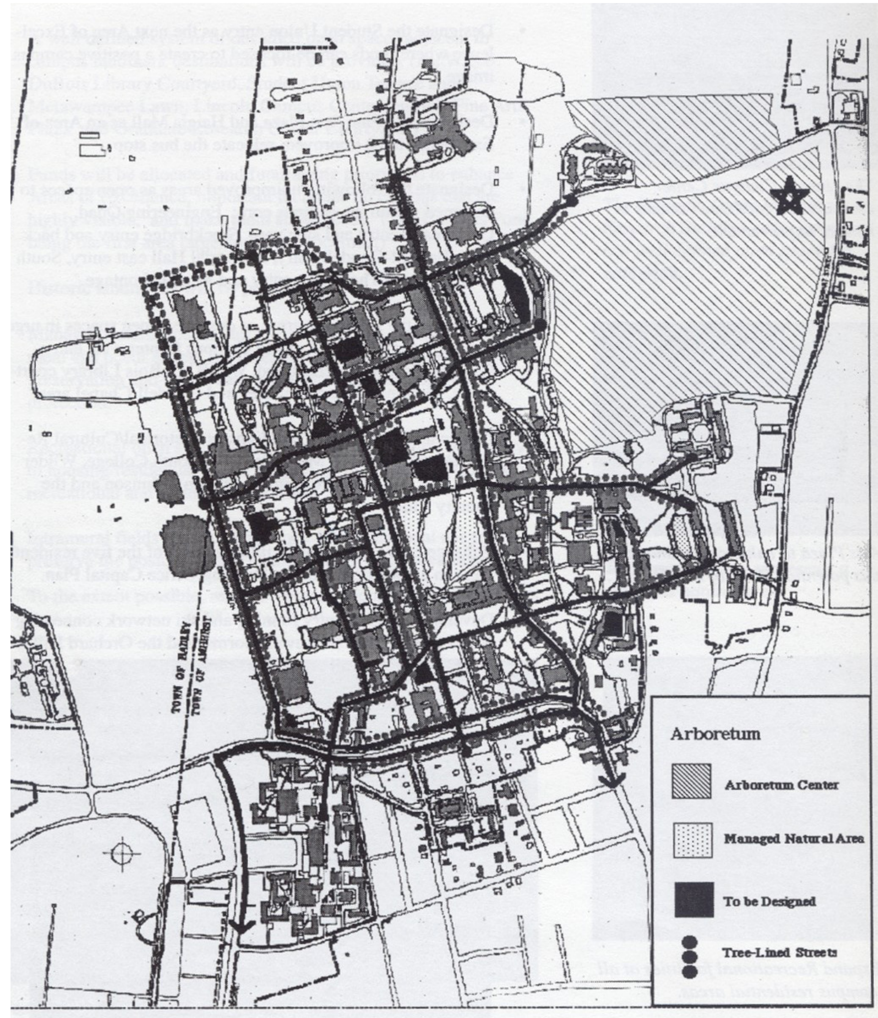


Figure 4.1. University of Massachusetts plan showing proposed visitor center location at Orchard Hill in the northeast corner of campus. Source: Ahern et al. 1993

embraced the idea of maintaining the Orchard Hill area of campus as open space and a future gateway to the University's Waugh arboretum (named in honor of Frank Waugh, founder of the landscape gardening program at the Massachusetts Agricultural College, precursor of landscape architecture and regional planning program at the University today). At present the arboretum is a collection of significant trees and woody plants diffused about campus. It lacks an identifiable organizing element that would help create an arrival and departure point for students and visitors who wish to experience the arboretum as a whole. Ahern et al. (1993) envisioned a visitor center near the corner of Eastman Avenue and East Pleasant Street as a way of creating such a destination and, together with a thoughtfully developed program for the adjacent open space, serving as one element of a complementary development for education and administration. The present proposal would be consistent with this concept and a plan for the site could also include public elements, meeting facilities, and spaces for informal learning.

To refine the concept for this learning landscape the following goals and objectives were established:

Goals

Articulate through design the client's vision for a learning center dedicated to landscape materials that is inspiring to students, faculty and the public;

Propose an approach to experiential learning that encourages creativity and innovation in sustainable design and construction.

Objectives

Develop an original design that integrates a new learning landscape for materials and the built environment with the existing vision for a University arboretum visitor center;

Explore sustainability and its relevance to the program elements of the site while understanding the relationship between materials, the built environment, and trends in hands-on design education;

Identify programmatic synergies and interests among potential user groups within and beyond the campus community in the development of the facility.

CHAPTER 2 LITERATURE REVIEW AND CASE STUDIES

Sustainability and the Built Environment

The question of how we create a future in which humans have access to resources of sufficient quality and abundance to sustain life is complex. Many influential writers of the 19th and 20th century, including Henry David Thoreau, John Muir, Aldo Leopold, and landscape architecture's own Frederick Law Olmsted, articulated elegantly the value of nature and natural systems to the health of humankind. Ian McHarg's cornerstone work, Design with Nature (1969), advanced the cause of bringing an ecological imperative to landscape architecture and the planning of urban spaces in an automobile-centric, suburban context. However it was Rachel Carson's Silent Spring (1962) that brought public attention to the lethal impact of certain industrial materials and chemicals in the global landscape and fostered a discussion about both dwindling natural resources with the hazards of environmental pollution. It set the stage for a greater awareness that the earth should be viewed as a closed system in which the entire cycle of extraction, production, application, and elimination of industrial materials in the built environment must be better understood if humans were to have a sustainable future.

"Sustainability" as a conceptual framework dates to the early 1970's and efforts by the International Union for the Conservation of Nature (IUCN, now the World Conservation Union) to suggest that continued economic growth and industrialization was possible without the extensive environmental damage of the previous industrial period (Adams 2006). It was the Brundtland Commission Report that first established the most commonly used definition of sustainability: the practice of meeting the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission 1987). The utility of this broad-reaching concept has often been praised in promoting the potential for economic development with low environmental impact. Adams (2006) notes that although the definition was vague (its appeal to many), it effectively captured the fundamental duality of economic growth: that it is associated with environmental degradation yet also needed to alleviate poverty. It is often expressed as the overlap of three human concerns: environment, social welfare, and economics and recognizes that success in any one of these areas is inextricably linked to the other two.

A major problem with the present concept of sustainability however is that it implies equal trade offs can be made between these three pillars of concern. The flaw is that physical resources on earth create a finite limit on human activity whereas social welfare and economics are more flexible creations of society (Adams 2006). Kibert et al. (2000) note that sustainability is affected by anthropogenic materials use due to (1) environmental effects of mass materials movement during extraction, (2) depletion of high quality mineral stocks for industrial use, and (3) dissipation of concentrated materials resulting from wear and tear. (The latter assumedly includes their contribution to the waste stream and any toxic effects from their production.) For this reason the management of materials and resources stands apart in the call for a more effective concept of sustainability for the 21st century (Adams 2006). This is increasingly seen as critical especially in light of evidence that the world is rapidly becoming less sustainable, not more (Vitousek et al. 1997).

New material technologies may also play a significant role in advancing sustainability in the built environment as it applies to landscape architecture. In their new book, Living Systems; Innovative Materials and Technologies for Landscape Architecture, Margolis and Robinson (2007) state, "Innovation in material technologies has been at the forefront of design discourse over the last decade. This emergence is the culmination of a widespread professional and academic recognition that knowledge of material properties and processes is fundamental to innovation in design applications, and further, that cross-fertilization among professional fields, as well as access to data outside of conventional territories, may broaden and advance the scope of landscape architecture" (see www.livingsystemsla.blogspot.com).

From the perspective of the built environment it is useful to examine several current approaches to sustainability and how they might advance the goals of the UMass project. The following are three conceptual frameworks through which sustainability and the built environment can be viewed.

Ecological Design

Ecological design can be defined as any form of design that minimizes environmentally destructive impacts by integrating itself with living processes (Van der Ryn and Cowan 2007). Its roots are ancient however beginning in the 1970s there were several influential projects that focused on shifting our contemporary perspective on the built environment towards a more holistic view of integrating food, energy, and waste management – what happens in ecological systems on a macro scale – in applications at the scale of small residential communities.

On the east coast of the United States the New Alchemy Institute on Cape Cod, Massachusetts began incorporating solar and wind energy systems with aquaculture, horticulture, and nutrient cycling in closed-loop systems that produced food and managed waste, all within "bio-shelters" based largely on the geodesic dome principles of R. Buckminster Fuller (Todd 2005; Hays and Miller 2008). Major demonstration projects – know as "arks" -- were built on Cape Cod and Prince Edward Island, Canada, both of which showed the potential of these ecological principles and provided vehicles for researching their intricacies (Figure 5.1). The work of the Institute continued for 20 years and spun off multiple think tanks and commercial enterprises focusing on one or more of the concepts developed in earlier years.

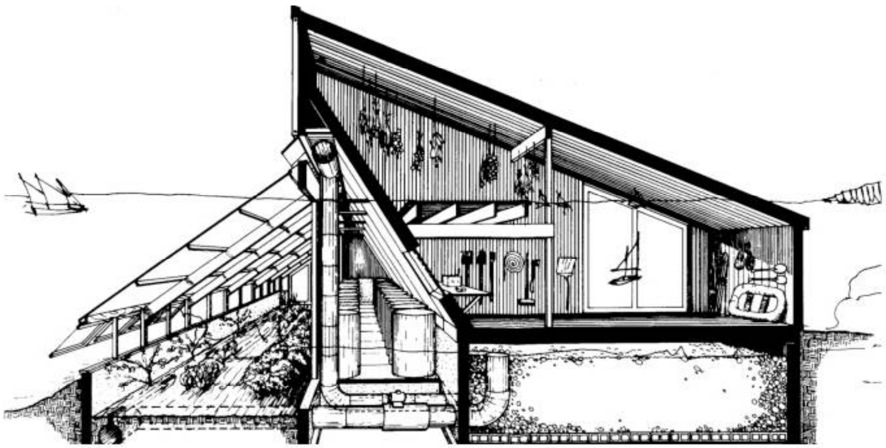


Figure 5.1. Bioshelter "ark" featuring closed nutrient system approach to sustainability. Source: New Alchemy Institute at www.vsb.cape.com/~nature/greencenter/bioshelter.html

Perhaps most notable is the ongoing work of a former Institute director, University of Vermont Professor John Todd, who continues to develop and promote "eco-machines" that produce plant biomass from organic waste streams (Fig. 5.2; see www.oceanarks.org, and www.toddecological.com).

Figure 5.2. Structures housing "living machines" that process wastewater with plants. Source: www.ecofriend.org/entry/living-machine-nature-helps-out-big-time-in-hydro-clean-up

Meanwhile on the West coast John T. Lyle at California State Polytechnic University at Pomona developed a conceptual framework for "regenerative" studies, processes that restore, renew or revitalize their own sources of energy and materials, creating sustainable systems that integrate the needs of society with the integrity of nature (Californian Integrated Waste Management Board 2004). More than ten years of planning and fund raising by students and faculty led to the construction of a mini-campus of buildings that used state-

Figure 5.3. The John T. Lyle Center for Regenerative Studies at California State Polytechnic University, Pomona, CA. Source: Mike Davidsohn.

of-the-art solar energy technology and grey-water recycling systems with the goal of creating a self-sustaining community (Figure 5.3). This experimental landscape is now called the John T. Lyle Center for Regenerative Studies (see www.csupomona.edu/~crs/) and has broadened it mission to address global-scale issues of food production, water conservation, energy production, waste management as well as continuing to study the built environment.

The efforts of Todd, Lyle and other researchers have dramatically advanced the field of ecological design by demonstrating ways in which the built environment can mimic natural processes that support life. These processes may even cross into the psychological. It has been proposed by such notable scientists as E. O. Wilson and Stephen Kellert that human affinities for what is generically referred to as "nature" are deep rooted in evolutionary heritage, part of the hard-wired development of the human brain (e.g., Wilson 1984, Kellert 1997). They refer to these attractions as "biophilia," which has been defined by Wilson as "the innate tendency to focus on life and lifelike processes."

Kellert (2005) suggests that a new mode of living and design should be embraced that goes well beyond the current trends of sustainability. He states that the built environment should be organized in ways that allow our innate tendencies to connect with nature to be fully realized and notes the many recent studies in which the inclusion of natural elements in such places as hospitals has demonstrable beneficial effects on health (e.g., Ulrich 1984). Kellert calls this concept "biophilic design" and states its goal as, "to elicit a positive, valued experience of nature in the built environment" (Kellert 2005, p. 124).

Psychologist Judith Heerwagen elaborates on biophilic principles by suggesting that water, biodiversity, biomimicry, sensory variability and enticement are all key elements in the design and construction of spaces for human habitation (e.g., Heerwagan and Haas 2001).

Whereas ecological design uses the application of biological and geo-chemical processes that mirror those in natural ecosystems to address issues of sustainability, another view of sustainability focuses more on the realm of the technological.

Construction Ecology

Construction ecology is a subcategory of industrial ecology involving the development and maintenance of a built environment (1) with a materials system that functions as a closed loop and is integrated with eco-industrial and natural systems; (2) that depends solely on renewable and recyclable materials; and (3) that fosters preservation of natural system functions (Kibert et al. 2000).

Applying the principles of construction ecology anticipates built environments in which buildings (1) are readily de-constructable at the end of their useful lives; (2) have components that are decoupled from the building for easy replacement; (3) are composed of products designed for recycling; (4) are built using recyclable, bulk structural materials; (5) have slow "metabolisms" due to their durability and adaptability; and, (6) promote the health of the human occupants (Kibert, C. 2005).

Construction ecology evokes many of the concepts put forward by William McDonough and Michael Braungart who suggest in their book Cradle to Cradle (2004) that a paradigm shift is needed in the way in which we approach the built environment. For them the adage of reduce, reuse, recycle is insufficient to tackle the enormity of the environmental challenges ahead. They argue that sustainability must be pursued as a design problem in which the long-term lives of products and materials must be anticipated and provided for, creating closed-loop, "eco-effective" industrial systems in which waste is essentially non-existent.

Within the construction and trade industries advances have been made to evaluate the impact of the built environment and to encourage sustainable and "green" construction. In 1998 the U. S. Green Building Council established the Leadership in Energy & Environmental Design (LEED) Green Building Rating System, a voluntary, consensus-based standard to support and certify "high performance" buildings (see www.usgbc.org) which today involves nearly 18,000 projects, including both residential and commercial units (Figure 5.4).

Figure 5.4. L.E.E.D. certified parking garage in Santa Monica, CA. Source: www.inhabitat.com/2008/04/14/first-leed-certified-parking-garage.

Also under development is the Sustainable Sites Initiative, an interdisciplinary effort by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center and the United States Botanic Garden to create voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices (see www.sustainablesites.org).

Landscape Tectonics

Sustainability in the built environment is an amalgam of ecological and technological approaches that also considers the benefits to the people for who those environments are created. Sustainable materials are at the core of these disciplines. Moreover, inasmuch as landscape architecture uses materials to not only define space and enhance the built environment but also to mitigate and remediate environmental impacts, the effective application of landscape materials is as important as the qualities of the materials themselves. To this end students must learn a level of craftsmanship above and beyond what might be acquired through theoretical or design work alone (e.g., Fig. 5.5).

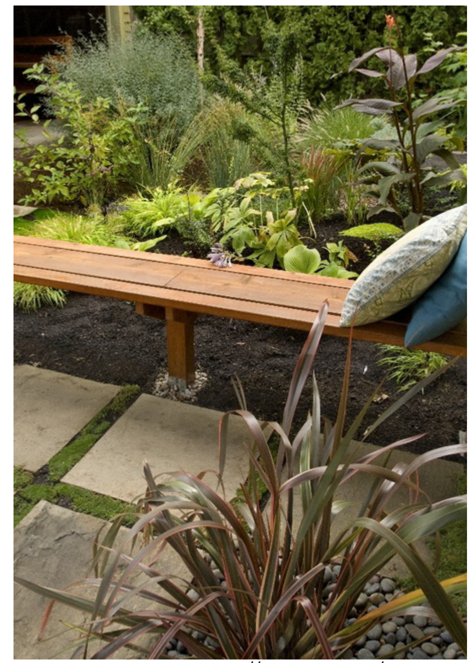


Figure 5.5. A small rain garden featuring a variety of materials and construction details. Source: blog. oregonlive.com hg_impact 2008 11 large_rainbench13

Niall Kirkwood calls this the art of landscape detail (Kirkwood 1999) and suggests that the knowledge of how things are actually built – i.e., an understanding of landscape tectonics -- is integral to the design process. The word "tectonics" derives from the Greek word, "techne" which implies a set of principles involved in the production of an object through craftsmanship or art (see www.ditext.com/runes/t.html). Kirkwood sees landscape tectonics as synonymous with (1) structural support, stability and the mechanics of joining; (2) the assembly of detail parts and how they are brought together or separated; and, (3) material selection (Kirkwood 1999 pg. 114).

Although these associations may seem more functional than aesthetic, the craft of landscape tectonics helps the beauty and elegance of constructed spaces to be revealed. It can be argued that creating spaces that instill a positive affective response to green infrastructure may inspire a greater enthusiasm within individuals for sustainable built environments than efforts to produce a cognitive understanding of its value to society as a whole.

Summary; Ecological Tectonics as a Unifying Concept

In many ways, the fields of construction ecology and ecological design represent what environmental educator David Orr from Oberlin College identifies as the dichotomy between technological and ecological approaches to sustainability. The former focuses on finding technological or market solutions to problems of sustainability whereas the latter suggests that answers can be found in mimicking the processes of nature and mitigating the processes that create unsustainable practices in the first place (Van der Ryn and Cowan 2007). I propose that the integration of ecological design and construction ecology with landscape tectonics might well create a dialog in which "eco-tectonics" can emerge as the study and application of landscape materials and construction techniques that advance sustainability of the built environment.

Today we see successful, high-profile projects where these three approaches have come together to create built environments that advance sustainability in ways that successfully apply the concept of eco-tectonics. Of significance is the work of Herbert Dreiseitl

(Dreiseitl et al. 2001, Dreiseitl and Grau 2006) in managing, revealing, and treating urban stormwater, particularly his notable urban plaza at Potsdamer Platz in Berlin, Germany. Within a dense urban context he has merged a highly interactive waterscape – a linear fountain with streams, riffles, and a lake -- with purifying phyto-remediation beds called "biotopes" that cleanse the water as well. Through the careful use of materials, slopes and landscape effects, the spaces he has created are playful and engaging, providing respite for people while contributing to the health of the urban ecosystem. Elsewhere the creative use of materials in raingardens is being promoted by Pennsylvania State University faculty Eliza Pennypacker and Stuart Echols under the moniker of "artful rainwater design" (e.g., Pennypacker and Echols 2008; see www.artfulrainwaterdesign.net), evidence that the type of effect accomplished at Potsdamer Platz can be replicated in smaller settings.

Case Study 1: John T. Lyle Center for Regenerative Studies, Pomona, CA

The John T. Lyle Center for Regenerative Studies at California State Polytechnic University (Fig. 6.1) is an example of an institution with far reaching goals for sustainability and experiential learning. The facility occupies 15,000 square feet of built space on 17 acres just south of the main campus. Originally envisioned as a live-in learning environment dedicated to showcasing state-of-the-art (for 1994) sustainable technology, the institute has now broadened its interest to five core areas of sustainability: food, water, energy, waste, and the built environment (including building and landscape materials).

Figure 6.1. The main building at the John T. Lyle Center. Source: Mike Davidsohn

The initial proposal of students and faculty was the creation of a community that made use of on-site resources, operated with renewable energy, and worked with biologically-based processes for food production and the recycling of waste. Building upon their research and drawing on the knowledge of a wide range of experts from throughout the world, the team published a proposal and a preliminary design, and raised $4.3 million from private foundations for construction. Ground was broken in 1992 for Phase I of and the Center welcomed its first 20 full-time residents in early 1994.

Since its inception the primary focus of the center has been the establishment of a closed system living community where food, energy and shelter are interconnected. The facility has on-site housing for twenty graduate or upper division students in two dormitory buildings as part of the Center complex. (These are administered through University Housing Services.) Power is provided largely by free-standing and roof-top solar arrays and one wind mill. Numerous permaculture gardens located on the site provided vegetables and fish are reared in aquaculture ponds. Kitchen scraps are composted in vermiculture units and green waste is composted separately. An interconnected system for wastewater treatment including the recycling of grey water

Figure 6.2 Lyle Center gardens and water management pond.
Source: Mike Davidsohn

is a central feature of the site (Fig 6.2).

The mission of the John T. Lyle Center for Regenerative Studies is reminiscent of efforts of the New Alchemy Institute (1971-1991) to integrate shelter, thermal massing, aquaculture and food production in a closed-loop technology by modeling large-scale interactive systems (Todd 2005). Today its focus has shifted from a sustainable community to research and studies that are more policy and innovation based. Classes are still conducted for undergraduates in areas related to the original mission (see Appendix B), however the fixed infrastructure does not lend itself to repeated trial and error design-build projects as is proposed for the UMass model. Moreover, the current faculty struggle with managing a built environment that was state-of-the-art for its period, but is no longer so (Brown 2009 per. comm.). From a siting perspective, the remote location of the Center is inconvenient for both students and the 2000 visitors who tour the facility annually (visitors must park in the Campus core and ride a shuttle to the Center) resulting in low visibility and awareness of the Centers activities (Brown 2009 per. comm.).

This project demonstrates the importance of providing a dynamic infrastructure that allows change associated with new technology and teaching needs. Similarly, a changing exhibition strategy is favored over a semi-permanent showcase for contemporary innovation. It also shows the need to ensure that a site has good visibility and connectivity to user audiences.

Case Study 2: The Eden Project, Cornwall England

Figure 6.3 The Eden Project, Cornwall, England. Source: www.theedenproject.net

The Eden Project (Fig. 6.3) is a major visitor attraction in Cornwall, England that opened to the public in 2001. Conceived as a UK Millennium Project for the public and developed by the non-profit Eden Trust, it has become one of England's premier gardens and conservation centers. Its mission is "to promote understanding and responsible management of the vital relationship between plants, people, and resources, leading towards a sustainable future for all." Unlike the Center for Regenerative Studies, The Eden Project's focus is on botanical collections and the relationships among plant communities within certain ecological regions. This is the core of its education and research programs.

The physical facility was built upon a 135 acre china clay open pit mine and transformed the former industrial site into futuristic landscape that evokes images of R. Buckminster Fuller and his vision for housing great cities under geodesic domes (see Hays and Miller 2008). Indeed, the two major biomes – reflecting tropical and Mediterranean plant communities – are enclosed within bubble-like geodesic structures of massive proportions (Fig. 6.3). The tropical biome is, in fact, considered the largest greenhouse in the world (Fig. 6.4). With architecture by Nicholas Grimshaw and Partners and engineering by Arup Engineering Group, these enclosures are a remarkable solution for the need to enclose expansive areas of plantings and pedestrian circulation with climate-controlled space.

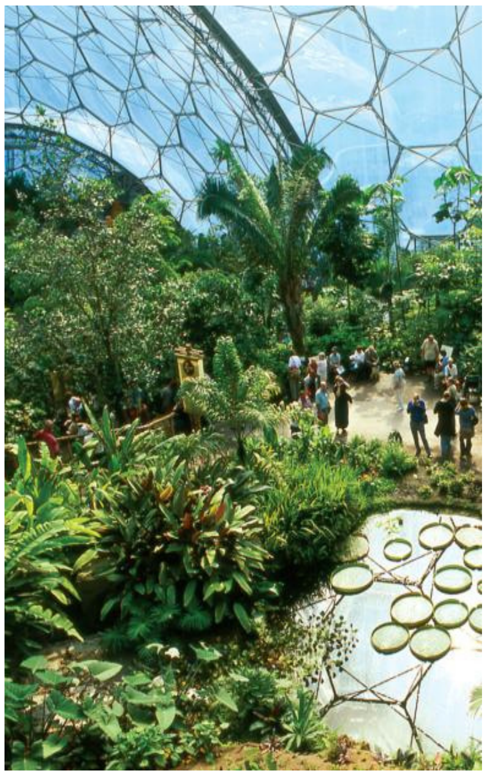


Figure 6.4. The Eden Project Tropical Biome. Source: www.martingoodman.com

Water management is also impressive, with subterranean drainage systems collecting all the rainwater entering the site, which is used for irrigation and non-potable domestic water, and grey water providing 43% of all additional water needs. In the tropical rainforest biome, humidity is provided by waterfalls and heat is released from southern-facing walls that serve as heat sinks that collect solar energy.

The translucent skin of the domes if made of a material called ETFE (ethylene tetra fluoro ethylene) a non-petroleum based polymer akin to Teflon that is highly transparent to ultraviolet radiation, self cleaning, projected to have a long life span (up to 100 years), and fully recyclable (Robinson 2005). It is constructed in multiple layers that are inflated to maximize insulation value and optimize transparency (Fig.

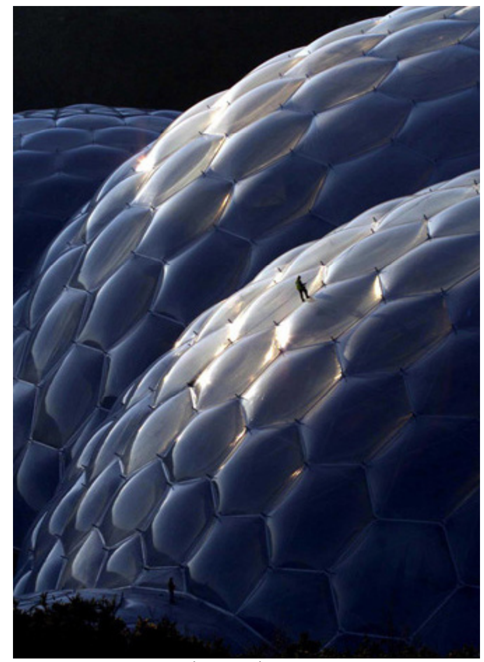


Figure 6.5. The Eden Project's ETFE domes. Source: www.theedenproject.net

6.5). A major fabricator of these ETFE pillow systems is VectorFoiltec (Bremen, Germany) though plastics manufacturers DuPont, 3M, and Nowofol produce the product as well. Inflatable cladding systems have seen broad application over the past decade in botanical gardens, zoological gardens, and swimming venues, including the "Water Cube" building of the 2008 Bejing Olympic Games.

The Eden Project has planted approximately 1 million plants of 4000 taxa (species and cultivars). The prioritization of species is mostly based on educational value rather than conservation value, except where certain species are needed to support a conservation story. The facility does not house a zoological collection, except for insect pollinators. Research includes integrated pest management systems that have significance in applications outside the Eden Project. The Eden Project states that their biomes are flexible and allow for an ever-changing assemblage of plants communities in the future.

Each year more than 1.1 million people visit The Eden Project, including 34,000 children in school groups (The Eden Project 2008). Much of the programming is focused on gardening and hands-on education. Revenue for operations comes from public sources, private fundraising (17%), gate revenues and gift aid (75%), and on-site rentals and musical events (8%). Extensive studies have been undertaken at The Eden Project to ensure the efficacy of their informal learning program. Its' newest component is The Core, an education center for which the chief executive Tim Smit said:

"I hate exaggeration so I'll tell you the simple truth. This is the finest modern building in the world, and anyone who says they can show me a better looking one is either a liar or clairvoyant. I could give you a lot of guff about inspirational education and the success of the Eden project, the genius of the architects and the artists involved, but it boils down to one thing. This building is a cathedral and it moves you and fills you with awe. (http://www.bfi.org/our_programs/bfi_community/eden_project)."

The Eden Project is clearly an amalgam of entertainment attraction and learning center. Acknowledging the purely aesthetic appeal of a massive botanical garden, it nonetheless creates an inspiring setting for learning about ecological relationships and sustainability.

Moreover, the building structures provide a thought-provoking view of alternative, sustainable architecture to which most people would otherwise have no exposure. Functionally, these domed structures have considerable merit in many applications now that cladding materials have progressed to a level well beyond the realm of R. Buckminster Fuller and his geodesic buildings of the 1960s and 70s in terms of insulative properties, recyclability, and sustainable production. Unlike the academic mission of the Center for Regenerative Studies, The Eden Project is meant to engage the public on a scale as expansive as its structures regarding sustainability, albeit in a less integrated and utopian model.

In summary, The Eden Project demonstrates the ability of a botanical attraction to draw large audiences (including k-12th grade school groups) and provide high-profile forums for sustainability issues. In general, strong attendance at public botanical gardens shows the potential for strong appeal amongst the general public. The value of geodesic (or similar) structures and ETFE cladding systems to create efficient, span-free, climate-controlled envelopes over large areas of landscape is also presented. Finally, alternative uses for public education venues – such as for music and social gathering – provide opportunities for engagement above and beyond the core mission as well as complementary sources of operating revenue.

Case Study 3: Charles Luck Stone Center Corporate Headquarters, Manakin-Sabot, VA

In 2006, the Charlottesville, VA landscape architecture firm of Nelson Byrd Woltz (see http://www.nbwla.com) was hired to create a

Figure 6.6. Charles Luck Stone Center showroom in Manakin-Sabot, VA. Source: www.nbwla.com.

masterplan, schematic design and design development documents for retail centers of the Luck Stone Corporation, one of the largest suppliers of construction aggregates in the United States. The first center to open, the Charles Luck Stone Center at the corporate headquarters in Manakin-Sabot, VA (Fig. 6.6) provides an interesting study for the showcasing of traditional landscape materials in inspirational ways.

The program for each of the centers had to include provisions for stone delivery and storage areas, a retail showroom, customer parking, contractor sales building, stone slab display, aggregate bins, and access for large truck loading and unloading. According to the Nelson Byrd Woltz website, the Charles Luck Stone Center site is eight acres in size (Figure 6.7). It features a combination of studios, contractor yards and workshops and offers thousands of stone products from around the globe for home building and landscaping.

Visitors are greeted at the entrance to the Stone Center by a steel-framed beacon containing two gabion baskets filled with stone and lit from within (Figure 6.8). A Datum Wall constructed of massive blocks of rough-quarried Pennsylvania sandstone leads them to the

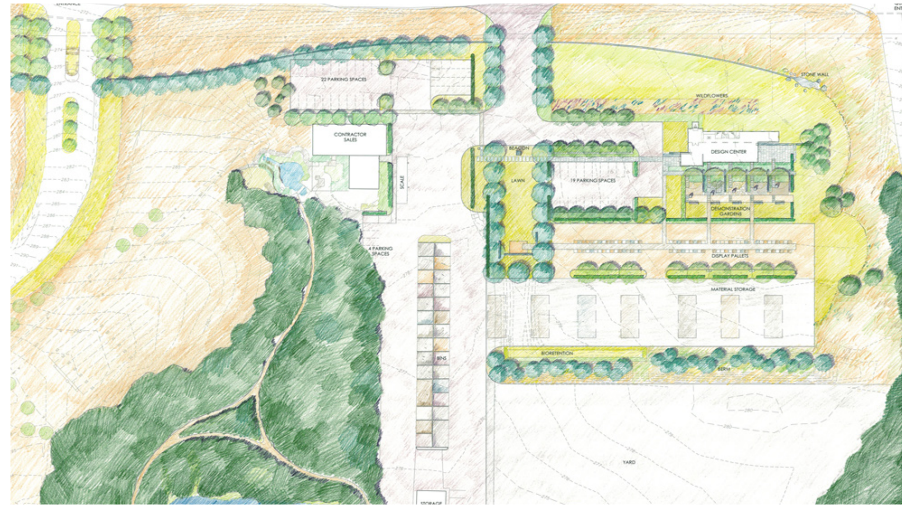


Figure 6.7. Charles Luck Stone Center site plan, Manakin-Sabot, VA. Source: www.nbwla.com.

Design Center showroom and display gardens. Tree allees establish the framework of the site, provide shade for visitors, and mitigate the dust created by truck traffic.

The design includes a contemporary studio building, five display gardens linked by a pedestrian spine which extends throughout the site and connects to a central green space that can be used for special events. Each display garden highlights the qualities of the stone products as well as the relationship between stone and plantings. There are interpretive signs and multiple sample pavements.

Nelson Byrd Woltz notes that sustainable design principles are used on the site as well. Contemporary stormwater management techniques such as bio-retention swales planted with native grasses and perennials collect runoff from the parking areas. Wildflower meadows substitute for turf, native species replace high maintenance plantings, and much of the stone come from domestic sources.


Figure 6.8. Iconic stone gabion at the Charles Luck Stone Center. Source: www.nbwla.com.

The significance of the Luck Stone site has less to do with sustainability and more to do with creating a place where landscape materials can be organized and showcased in engaging ways. More often than not, retail stone centers are working landscapes where customers encounter materials in ways more conducive to storage and shipping rather than exhibition (e.g., stone for retaining walls usually sits on pallets awaiting purchase and delivery). Traditional landscape materials (earth, water, plants, structure) are essential to the construction of sustainable landscapes. The UMass proposal recognizes that beauty and aesthetics are an integral element of sustainability, something argued by both landscape professionals and theoreticians (e.g., Meyers 2008). Outreach is an important component of this proposal therefore successful, museum-like retail designs such as the Luck Stone Center are worthy of examination.

The Luck Stone Center is a reminder that through creative, site specific design ordinary materials can be presented in extraordinary ways. It also shows that when dealing with the problem of handling and displaying loose bulk materials, a sense of organization can be created by borrowing the concept of orderly frames from ecological design (Nassauer 1995) and clearly delineating pedestrian space with strongly defined edges. Moreover, in landscapes of an industrial nature safety can be maintained by a well defined hierarchy of spaces that effectively separate user groups.

Case Study 4: Tower Hill Botanical Garden, Boylston, MA

Tower Hill Botanical Garden is a not-for-profit public garden situated on 132 acres in Boylston, MA (Fig. 6.8). The history of the garden dates to 1840 with the organization of the Worcester County Horticultural Society which owns and operates the facility. The Garden at Tower Hill was established in the 1980s and has been steadily expanding according to a masterplan first proposed in 1988. The full build out of an updated masterplan (Figure 6.9) is not projected for completion until 2040, however today the garden buildings consist of a circa 1727 farmhouse, which houses administration offices and rooms available for businesses meetings; and, the Stoddard Education and Visitors Center, which houses The Great Hall gathering space (doubling as Twigs Café), a theater with seating for 88, a banquet facility, a gift shop, and on the lower level a classroom and library. Perhaps most impressive is the 4000 square foot Victorian-style Orangerie which houses the garden's collection of cold intolerant plants in winter and

Figure 6.8. The Orangerie at Tower Hill Botanical Garden. Source: Neal Overstrom.

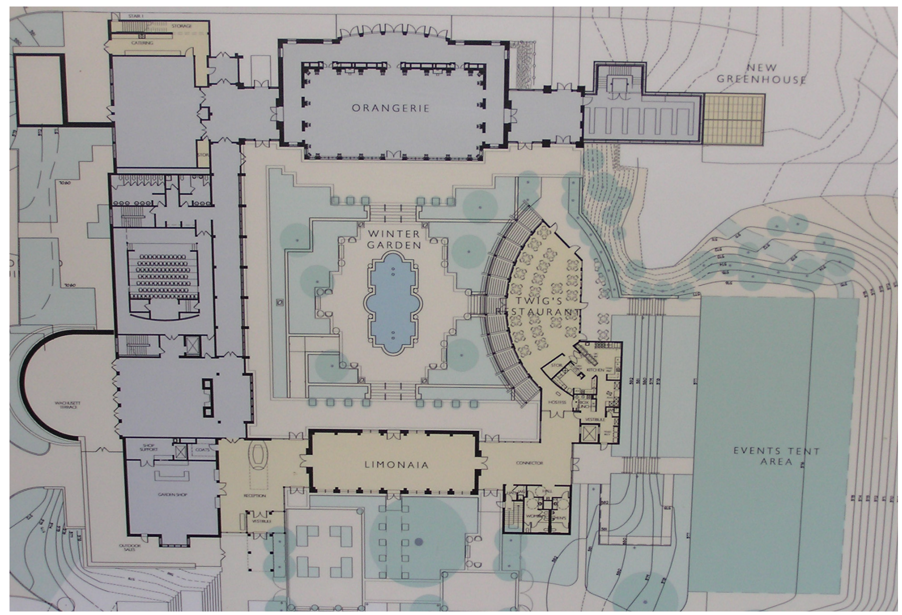


Figure 6.9. Site Masterplan showing recent improvements (blue) with proposed additions (yellow). Source: Tower Hill Botanical Garden.

hosts wedding gatherings and other revenue generating events in warmer weather.

The outdoor gardens are extensive and walking trails extend throughout the property that can be access year-round, weather permitting. Annual attendance is approximately 65,000 and has been growing with the facility's expansion (Vieira 2009 per. comm.). No doubt part of the success is due to the extensive list of year-round classes, lectures, workshops, certificate programs and symposia offered for adults by the New England School of Gardening at Tower Hill Botanical Garden and as well as classes for children, their families and educators by the Tower Hill Farm School. Tower Hill also organizes public events around their collections (e.g., a Camellia show in February 2009) and regularly hosts professional musicians on weekends.

Future elements of the masterplan include an expanded restaurant operation, limonaia, winter garden, and large events area.

Non-profit organizations that operate public displays and informal learning centers (e.g., zoos, aquariums, museums, science centers, botanical gardens, arboretums) must be creative in raising funds for capital improvements and for generating operating revenues. Fees paid by the public for admission are seldom adequate to cover operating expenses. Moreover, competition for leisure time in today's society is great as are the choices for leisure activities. To be successful in both mission and finance informal learning centers must provide a variety of services of value to patrons and user groups and must ensure that they optimize their assets for revenue generation. Increasingly, these needs are being met in informal learning environments by a combination of for-profit and not-for-profit partnerships and, in the case of public entities, public-private partnerships (Utt 2005). These partnerships often provide access to private funding for capital improvements above and beyond philanthropic sources. Moreover, informal learning environments (such as botanical gardens) often provide attractive settings for revenue generating functions that provide a competitive advantage over traditional venues and expose new audiences to their programs and activities.

Tower Hill Botanical Garden is a vibrant institution revealing that on-site programming for a variety of public audiences can both advance the mission of an informal learning center and provide critical sources of operating revenue. As with The Eden Project a demand exists for the type of experience provided by a botanical garden, particularly when it is paired with social and cultural events that include food and music. Botanical gardens can offer programs relevant to life-long learning that provide a framework for promoting conservation, sustainability, and the importance of green and healthy lifestyles.

Case Study 5: University of New Hampshire's Stormwater Center, Durham, NH

Some academic centers have specific areas of focus relative to sustainability. Such a case is the University of New Hampshire's Stormwater Center in Durham, NH (Fig. 6.10) a facility that provides the controlled testing of stormwater management designs and devices (Roseen et al. 2007). The UNH Stormwater Center is dedicated to the protection of water resources through effective stormwater management. The mission of the center is twofold: (1) research and development of stormwater treatment systems; and (2) to provide resources for the stormwater management community currently facing

Figure 6.10. The University of New Hampshire Stormwater Center at the West Edge parking area of the Durham, NH campus. Source: University of New Hampshire Stormwater Center 2007 Annual Report.

the design and implementation of systems that comply with Phase II requirements of the National Pollutant Discharge Elimination System (NPDES) program as established under the Federal Clean Water Act.

To help achieve this mission, a study site was constructed in 2004 adjacent to a 9 acre commuter parking lot which provides run-off for researching various stormwater management applications (Fig.

6.11). This site provide research opportunities into three classes of stormwater treatment: (1) conventional, structural Best Management Practices (BMPs) such as stone-lined swales, vegetated swales, filter berm swales and retention ponds; (2) Low Impact Development (LID) stormwater designs such as porous asphalt, pervious concrete, street tree filters, bio-retention systems, and a sub-surface gravel wetland; and, (3) manufactured BMPs such as hydrodynamic separators and subsurface infiltration/filtration systems (Roseen et al. 2007).

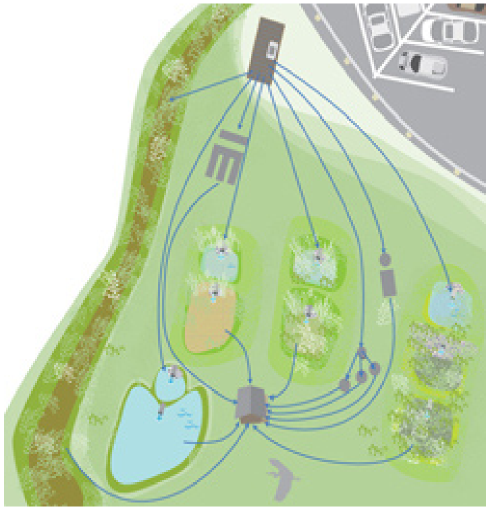


Fig. 6.11. The UNH Stormwater Center uses runoff from traditional parking surfaces to test infiltration strategies. Source: UNH Stormwater Center.

Outreach efforts include routine Technology Demonstration Workshops and hosting annual meetings for professional associations, government agencies, and others. Educational activities include publication of a Biannual Data Report on stormwater system performances, presentations at regional and national venues, website resources, an Innovative Stormwater Management Database for the region, and publications in refereed journals. The Stormwater Center partners with a variety of public and private groups. A Technical Advisory Board provides advice and expertise, and includes academics, state and federal regulators, local government officials, and industry representatives.

The UNH Stormwater Center is significant from two perspectives. First, from a sustainability standpoint the mitigation of stormwater run-off is fundamental, particularly in urban areas where contaminants from city streets and vehicle parking lots have the potential to channel toxins into aquatic habitats. The ability to test the efficacy of stormwater treatment systems under controlled conditions is critically important and can greatly contribute to our understanding of materials and their application in these settings. Second, it provides a valuable technical resource for local communities as they struggle to both enhance the quality of their environment and comply with federal regulations mandating levels of performance for municipal water management.

In this way the services of the center go beyond education to applied technology.

The UNH Stormwater Center illustrates that existing assets and infrastructure can support research and education initiatives. They have a clearly defined mission that guides both the development of the program and facilities. By establishing multiple partnerships in the public and private sectors with overlapping interests a base is established for funding and programmatic support.

User Groups

The project envisions multiple user groups associated with the three core functions of education (formal), research, and outreach (informal learning). The assets needed for teaching sustainable landscape construction (bulk material handling and storage, access to water, ability to move earth) will have value to other University programs that teach or field test interventions in the built environment. Moreover, linkage to professional trade associations, building materials manufacturing groups, and segments of the public interested in horticulture will expand the program scope and influence decisions regarding siting and layout of the facility.

Table 7.1 summaries the research and teaching interests of several University Departments and programs having overlapping interests with the Department of Landscape Architecture and Regional Planning. Table 7.2 identifies specific areas where potential synergies exist between departments and opportunities for collaboration exist.

Table 7.1. Select University departments and programs with teaching or research interests related to a sustainable built environment.

UMASS DEPARTMENT	PROGRAM	RELEVENT TEACHING/RESEARCH AREAS
Landscape Architecture and Regional Planning	Landscape Architecture; Stockbridge School for Landscape Contracting; Environmental Design	Theory, processes and techniques used in landscape design Design, implementation and maintenance of landscape projects Ecological integrity of the environment Landscape detail UMass Arboretum
Art, Architecture & Art History	Architecture + Design	Interior and architectural design Building systems and material science Arts, technology and society Architectural detail
Civil and Environmental Engineering	Structural Engineering Facilities Environmental and Water Resources Engineering	Experimental testing of large-scale structural elements Drinking water, wastewater, water resource systems, environmental biology Hydrology
Geosciences	Geology	Hydro-geological and geophysical field methods
Mechanical and Industrial Engineering	Center for Energy Efficiency & Renewable Energy (CEERE) /UMass Wind Energy Center	Energy production, industrial manufacturing, and commercial activities and land-use practices
Natural Resources Conservation	Building Materials and Wood Technology Environmental Science Arboriculture	Structural and physical performance of engineered wood products, wood-based composites, and wood framed building systems Ecosystem health Soil science Phyto/bioremediation
Plant, Soil & Insect Sciences	Plant and Soil Sciences The Stockbridge School	Phytoremediation Turfgrass management, horticulture Sustainable agriculture
UMass Extension	Agriculture and Landscape Natural Resources & Environmental Conservation	Water resource protection Agriculture and aquaculture Residential gardens Turf management Soil and plant nutrition

Table 7.2. Opportunities for collaboration and synergy across select University department and programs.

UMASS DEPARTMENT	Horticulture/Arboriculture	Spatial Design	Planting Design	Phyto/Bioremediation	Structural Testing	Material Performance	Building System Performance	Hydrology	Construction Detail	Green-roof Technology	Stormwater Management
Landscape Architecture and Regional Planning	+	+	+	+	+	+	+	+	+	+	+
Art, Architecture & Art History		+			+	+	+		+	+	
Civil and Environmental Engineering				+	+			+			+
Geosciences					+			+	+		+
Mechanical and Industrial Engineering					+	+	+				+
Natural Resources Conservation	+		+	+	+	+	+	+	+	+	+
Plant, Soil and Insect Science	+		+	+				+		+	+
UMass Extension	+		+	+						+	+

Siting and Program Requirements

Siting requirements considered (1) accessibility for the variety of user groups; (2) visibility for the promotion of programming and public outreach; (3) the ability to meet the program requirements in terms of space for teaching, research, gatherings of people from within and beyond the University community; and (4) an environmental assessment as to suitability of the site for development. Accessibility meant convenient access to public transit and pedestrian routes (both student housing and other teaching facilities on campus) – these are of particular importance to student user groups; and, clear and convenient linkage to the major vehicular circulation routes in the Amherst region and beyond – these are of particular importance to visitors to the center. Visibility means good connectivity to the Campus core and ability of buildings and program activities to be seen by large numbers of passersby. Program requirements included the need for climate-controlled, semi-enclosed and open spaces for teaching and research as determined by faculty and administrative staffs (Table 7.3). Finally, the environmental assessment must include an analysis of vegetation and habitat quality that exist on the site, slope and topography, solar orientation, adjacent land uses, and historical uses. To ensure that the proposed site at Orchard Hill best met these requirements two alternative sites on campus were identified and evaluated (Fig. 7.1). One site located south of the sports stadium (Site A) was impacted by surrounding wetlands and geographically removed from the campus core. A second site (Site B) was located in better proximity to The Stockbridge School and agricultural program activities, however the adjacent land uses were associated with campus infrastructure (parking, transportation facilities, co-generation plant) and removed from student housing. The original Orchard Hill site (Site C) was located a reasonable distance to the campus core; was adjacent to two large student housing units and pedestrian friendly; and had good visibility at the northeast corner of campus despite being away from major campus gateways to the south. It remained the favored location.

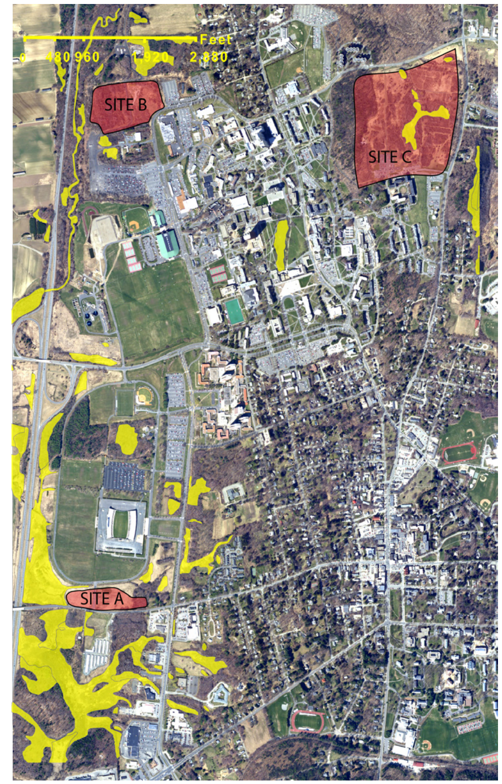


Figure 7.1. The locations of three sites (red) reviewed under siting requirements (Wetlands in yellow; Orchard Hill in the upper right).

Table 7.3. Preliminary program of areas for enclosed spaces.

PROJECTED SPACE REQUIREMENTS UNDER SHELTER	TOTAL SF	NOTES
Lobby and Reception	700 SF	Reception station and foyer; office
Public/Botanical	5000 SF	Strolling garden; temporary exhibit and demonstration area
Indoor Lecture and Demonstration Theater	1600SF	Stage area w/ loose aggregate base opening in concrete floor; seating for 75; video projection
Office/Admin	200 SF 400 SF	Semi-private space; student/work-study space with 2-3 computer work stations minimum, 2-3 drafting tables
Indoor Research	7500 SF	Sub-dividable open space; plenum for water infiltration and recycling below working deck
Research Offices	1500 SF	Individual offices/workspaces
Research Material Storage	2000 SF	Lumber racks; pipe racks; secure storage bins; tool crib
Indoor Teaching	8000 SF	Sub-dividable open space; plenum for water infiltration and recycling below working deck
Teaching Material Storage	3000 SF	Lumber racks; pipe racks; palletized paving and block; tool crib; sand, stone, mulch bins
Indoor Exhibition	8000	Includes café area, storage, and circulation
Plant material storage	n/a	Other campus location
Bulk Water Storage	700 SF	30,000 gallon (4000 CU FT) capacity reservoir; pump room with (2) pumps, high-rate sand filter and backwash holding tank
Materials Library	1800SF	Unit storage racks; tables, chairs; office, preparation and conference room
Restrooms	400 SF 300 SF 300 SF	Dedicated public access, student access, and utility room: all ADA accessible
Living Machine, Greenhouse/Botanical Garden	5000 SF	Wastewater treatment center – additional building footprint with other components integrated with existing greenhouse structures; does not include wetland component (Note: Oberlin College – 12,500 SF for 2000 GPD effluent).
TOTAL	46,400 SF	

CHAPTER 4 APPLICATION

A Site Analysis of Orchard Hill

Orchard Hill (Figs. 8.1 and 8.2) consists of approximately 60 acres of former agricultural land and University research orchards. Figure 8.3 shows the transition from the 1939 when the site was under active management to 1999 long after it was abandoned following the establishment the Cold Spring Orchard Research and Education Center, in Belchertown, MA. Today some living apple trees still exist, however most of the site has been overgrown by invasive plants such as multiflora rose (*Rosa multiflora*) and Oriental bittersweet (*Celastrus orbiculatus*). The rolling terrain (Fig. 8.4.) consisting of wetland areas, successional uplands, open fields and stands of mature trees is bordered to the west by the densely-wooded Mount Pleasant; to the north by Eastman Lane and the Sylvan student residence complex; to the east by East Pleasant Street (a link to downtown Amherst and Route 9); and to the south by the access road and parking lots of the Orchard Hill student residence. Paths and service roads that mirror historic boundaries are maintained by mowing.

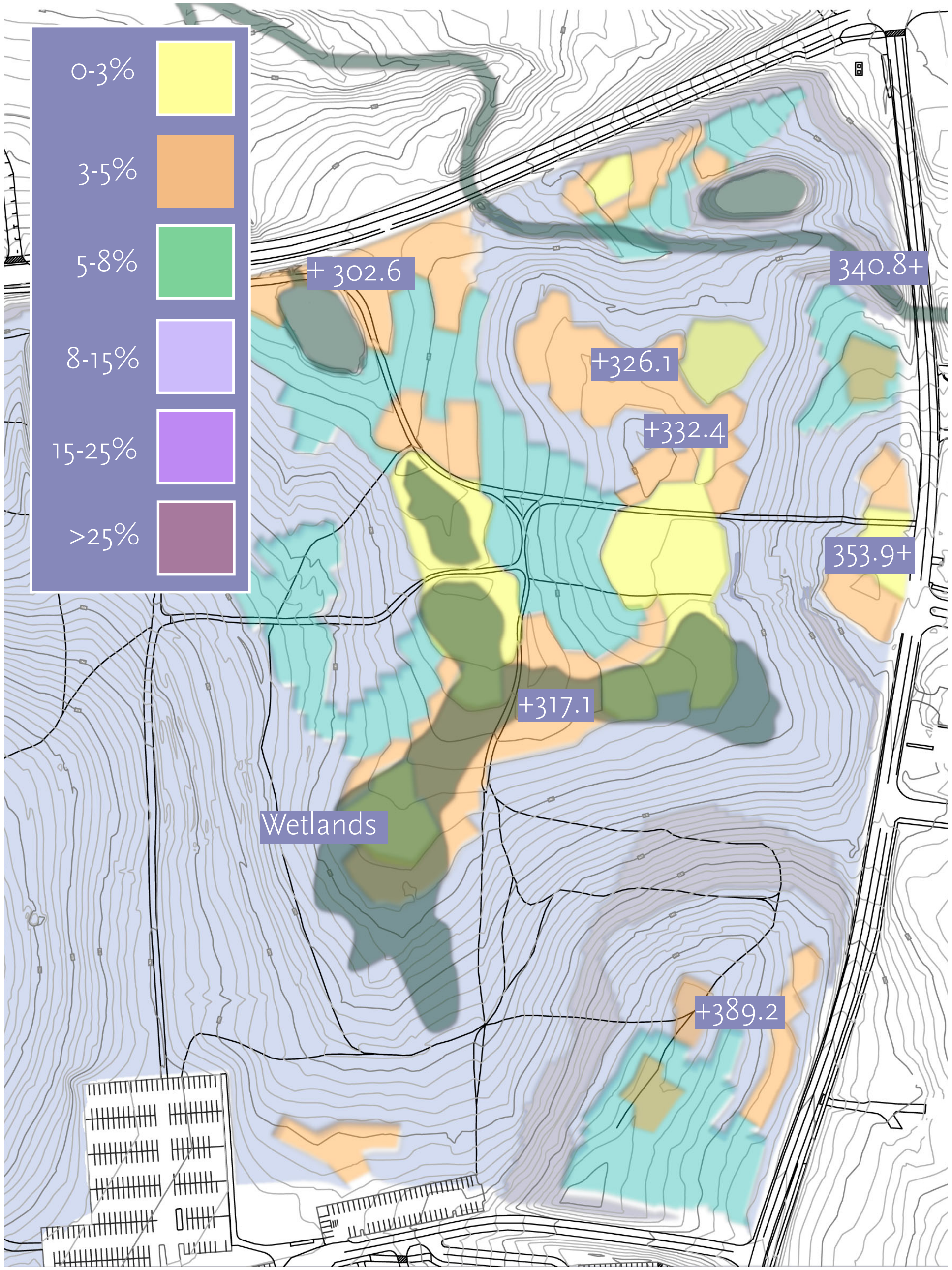
Figure 8.1. Aerial view of the University of Massachusetts campus. The Orchard Hill area is located to the northeast near the intersection of Eastman Lane and East Pleasant Street.

Figure 8.2. Aerial view of the Orchard Hill area of campus showing a variety of landscape typologies from open field to densely vegetated wetlands. Parking lots at the northwest and southwest corners of the site were constructed within the past ten years.

Figure 8.3. Aerial photos of the Orchard Hill area of campus showing sixty years of change in the landscape.

1939 1952 1985 1999

Figure 8.4. Slope analysis for the Orchard Hill area of campus revealing significant grade changes over a rolling topography. Two retention ponds occupy the northern area of the site, spot elevations are indicated, and seasonal streams and wetlands are shown in dark shading.



Land Use, Connectivity, Public Transportation, Parking

Orchard Hill is designated as open space, which together with pasture and forested land remains the dominant land use reflecting the agricultural heritage of the University of Massachusetts area (Fig. 8.5). Aside from small residential areas to the east and north, most of the surrounding land uses that are not open space are either institutional (i.e., owned by the University) or municipal (e.g., a fire station owned by the Town of Amherst at the intersection of Eastman Lane and East Pleasant Street). University operations located near Orchard Hill that may be complementary to the proposed center's activities include the grounds care facility as well as the recycling center. Pedestrian connections to the campus core exist along Eastman Lane and from the Orchard Hill residences along Chancellor Drive to the south with linkage to the Waugh Arboretum (Fig 8.6). Pedestrian walks along east Pleasant Street are absent, however the Pioneer Valley Transit Authority (PVTA) has bus routes that run both north and south on the Blue Lines 34/ 35 with continuous daytime service every 15 minutes (Fig 8.7). These loop back to the campus core providing excellent access to the site via public transit. More than 550 parking spaces exist in paved lots adjacent to the Sylvan and Orchard Hill residences which are dedicated to student vehicles. These spaces could be available for event parking when classes are not in session. In addition, more than 500 additional spaces exist in three locations on Olympia Drive to the east of East Pleasant. These are within easy walking distance of the Orchard Hill area under consideration for the project (Fig 8.8) and would be the first choice for visitor parking. They do not appear at capacity and even appear expandable. With such favorable connectivity to the campus core and parking in existing lots no supplemental parking spaces are planned.

Vegetation

Figure 8.9 reviews patterns of existing vegetation. As previously noted, woody plants often characterized as invasive dominate much of the landscape, such as glossy buckthorn (*Rhamnus frangula*), Oriental bittersweet (*Celastrus orbiculatus*), and multifora rose (*Rosa multiflora*). In many areas they form an impenetrable mass that engulfs other vegetation including occasional apple trees from the former orchards. Pin oak (*Quercus palustris*) is common in many sections. Red maple (*Acer rubrum*) and quaking aspen (*Populus tremuloides*) dominate the wetter soils along with non-woody indicator species such as sensitive fern (*Onoclea sensibilis*) and common cattail (*Typha latifolia*) in areas adjacent to standing water. Significant trees such as mature shagbark hickory (*Carya ovata*), sugar maple (*Acer saccharum*), white oak (*Quercus alba*) and black oak (*Quercus velutina*) occupy upland sections and roadsides.

Figure 8.5. Land uses surrounding the University of Massachusetts campus including the Orchard Hill area.

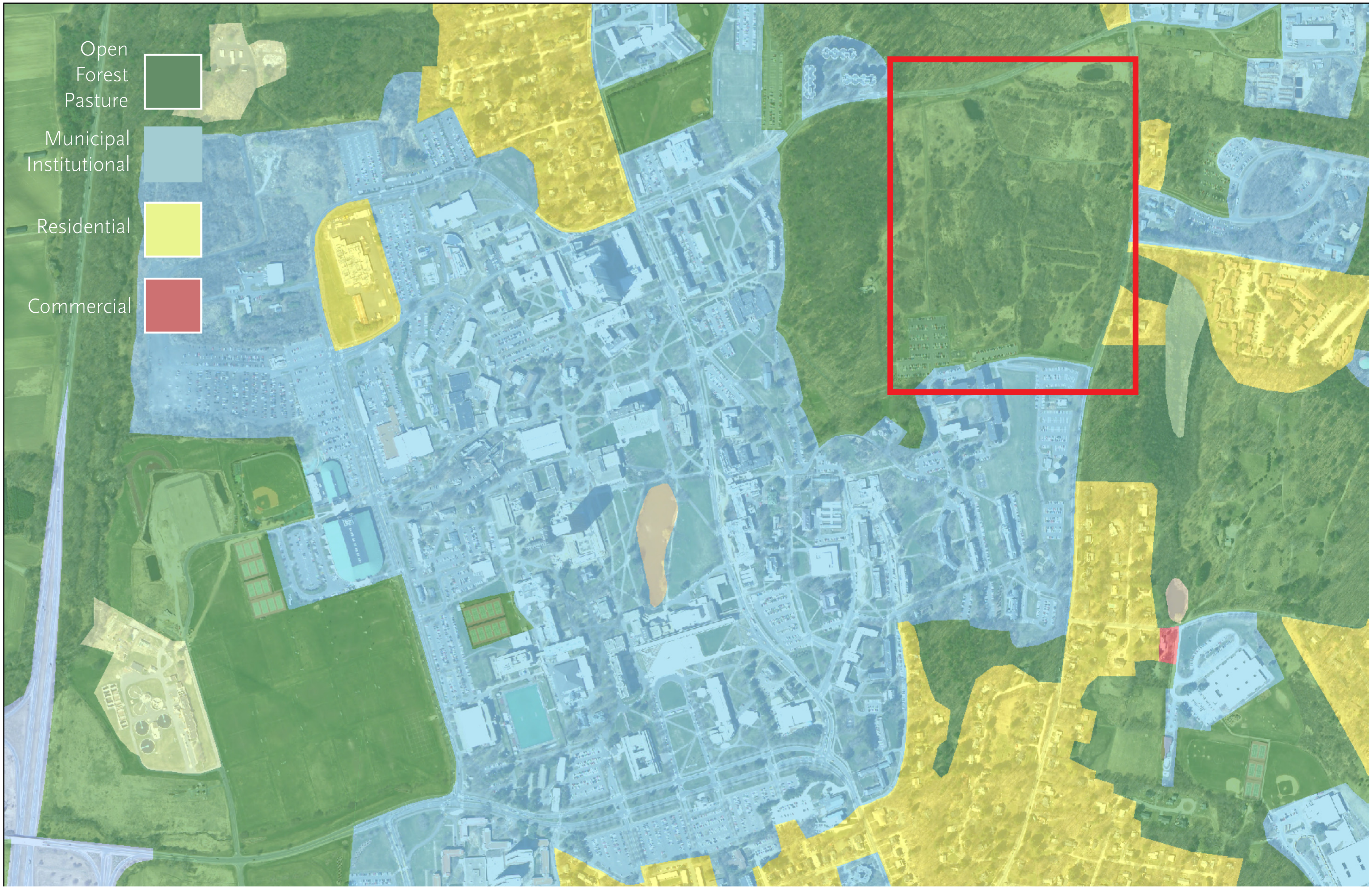


Figure 8.6. Primary pedestrian routes (cyan) from Orchard Hill to Campus Center and linkage to three existing loops of the Waugh Arboretum (red, blue, yellow).

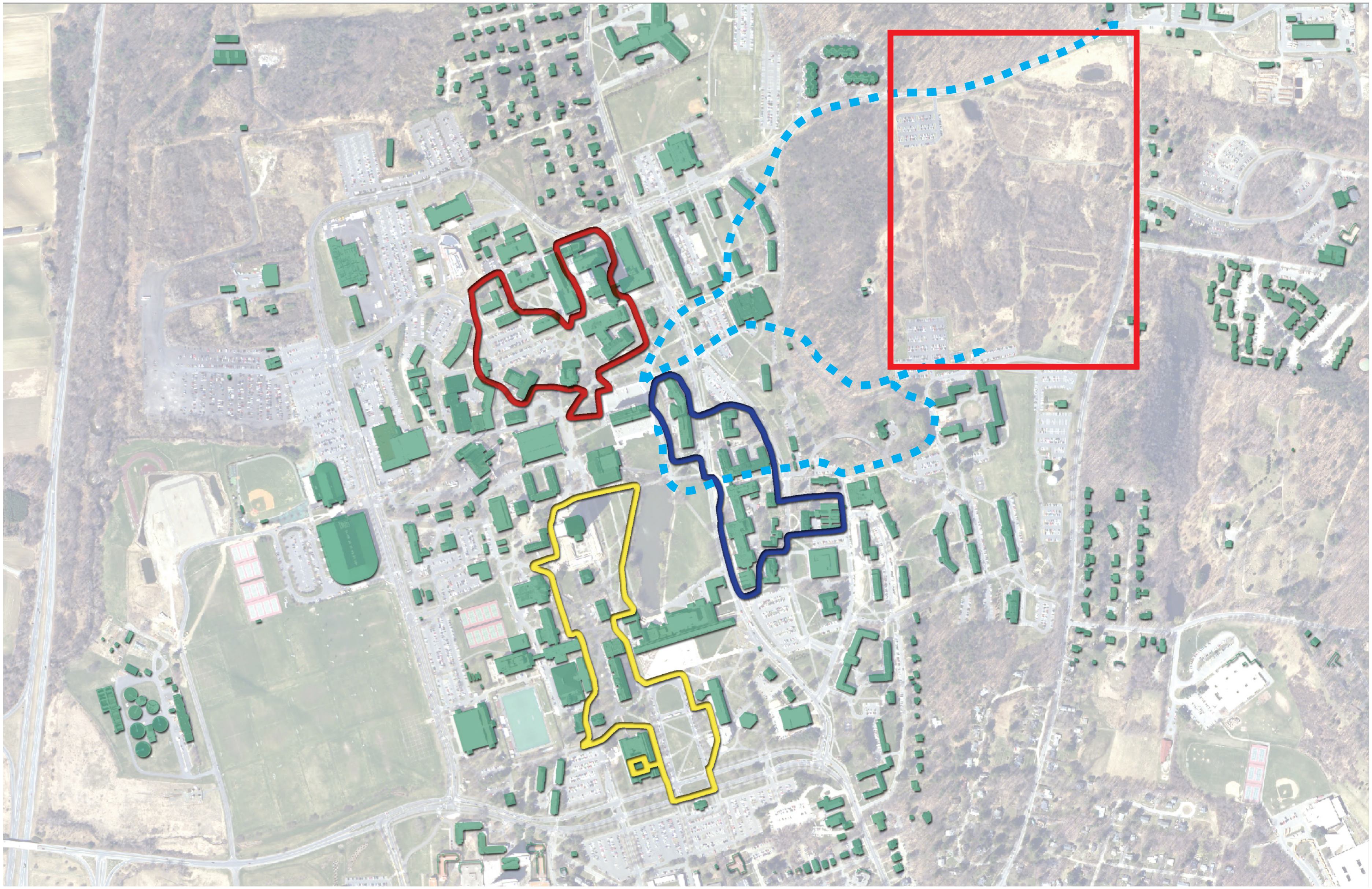


Figure 8.7. Pioneer Valley Transit Authority (PVTA) bus routes in proximity to the University of Massachusetts campus. Existing stops near Orchard Hill are noted.

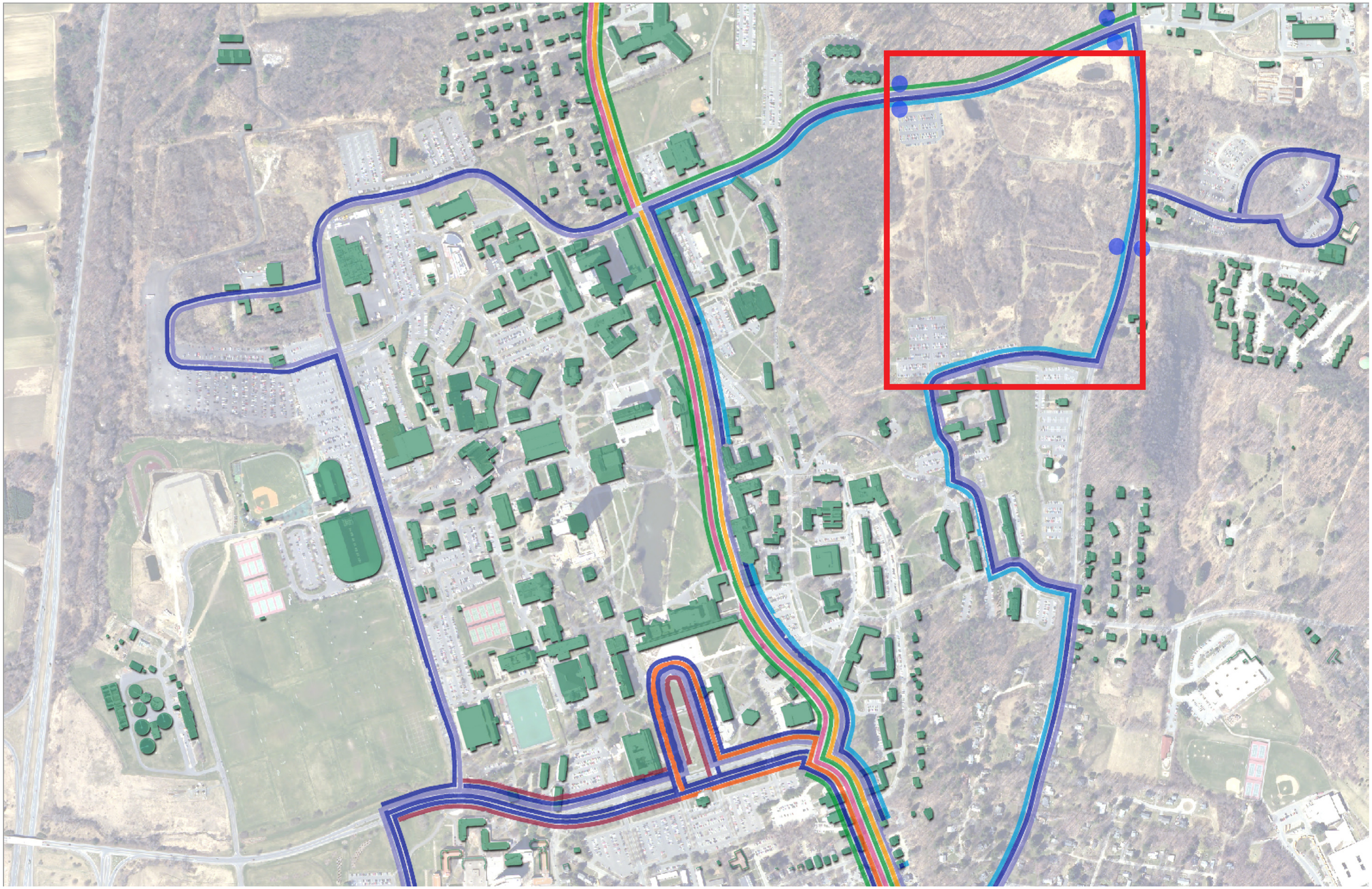


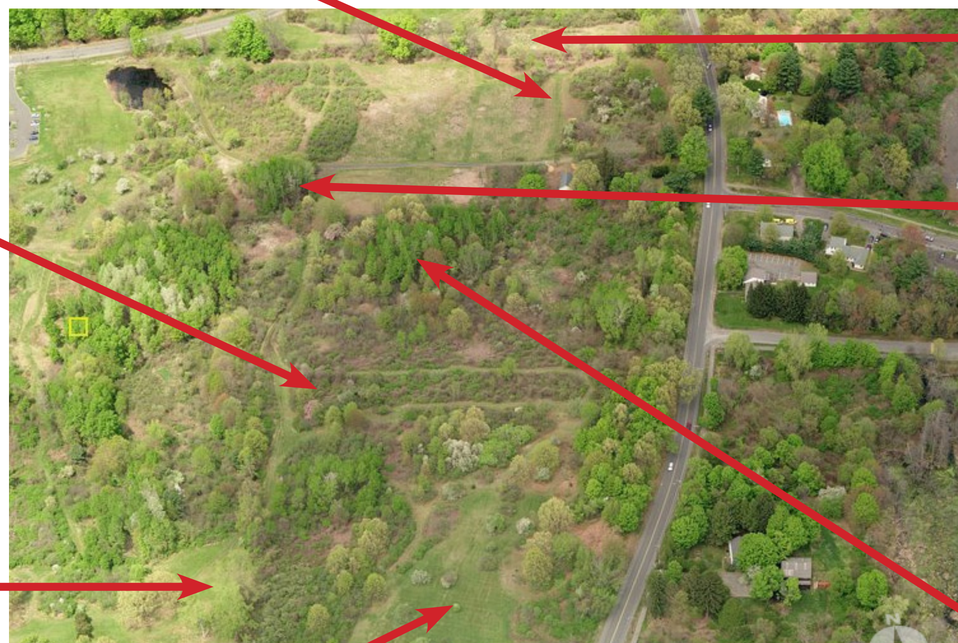
Figure 8.8. Major parking lots on the University of Massachusetts campus are shown in grey.

Figure 8.9. Existing Vegetation

View from the field toward East Pleasant Street with mature oak, hickory and white pine trees marking the road edge.

Mature hickory and sugar maples parallel the 100' buffer to stream.

Bittersweet and multiflora rose overwhelm dead apple trees.



Mature willow and stand of quaking aspens mark the edge of the open field and wetland beyond.

Stands of glossy buckthorn create a wall of vegetation along the mowed field.

Mowed field adjacent to Orchard Hill residence parking with living remnant apple trees.

Dense thicket within the wetland area dominated by red maples.

After evaluating the possible areas for development the northeast section of Orchard Hill was selected for the Center for Innovation and Exploration in the Built Environment. This location was first identified by the LARP department faculty as a likely site, the former location of a farmhouse and barn that dated to the 1800's (Fig 9.1.). It features a relatively flat upper plateau along East Pleasant Street where the farmhouse once stood, a steep slope to the west followed by open fields stretching to the wetlands that border the site to the west and south. This portion of Orchard Hill has the largest area of relatively flat terrain and best solar exposure to the south and southwest.

The inspiration for the design emerged from the topography (Fig. 9.2). Acknowledging that much of the landform would necessarily be under a structure, from the beginning it was intended that any building should simply be an envelope over the landscape rather than an object upon it (Fig. 9.3). To that end a number of forms were explored, including geodesic domes reminiscent of both The Eden Project and the bio-shelters of the New Alchemy Institute. Ultimately the design concept was based on three dominant landform elements -- a narrow, wooded upper terrace; a

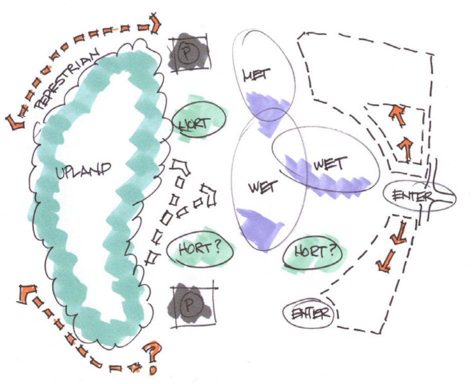


Figure 9.1. Site analysis diagram

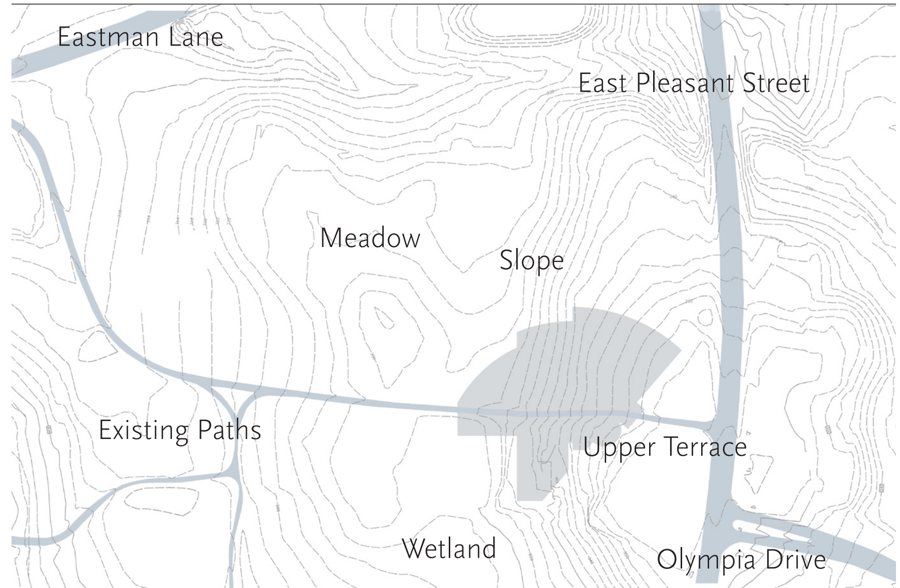


Figure 9.2. Landform pattern

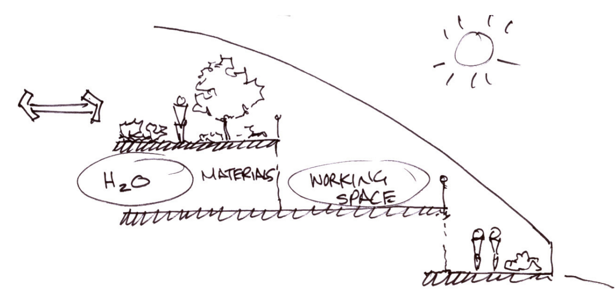


Figure 9.3. Terraces beneath building envelope.

steep adjacent slope; and, an expansive meadow -- which fan out to the north and northwest from a point where the upper terrace, slope and wetland boundary converged close to East Pleasant Street (Fig. 9.4). The 20 foot grade change allows three interior working levels to be built along the hillside that reach out to the exterior landscape beyond.

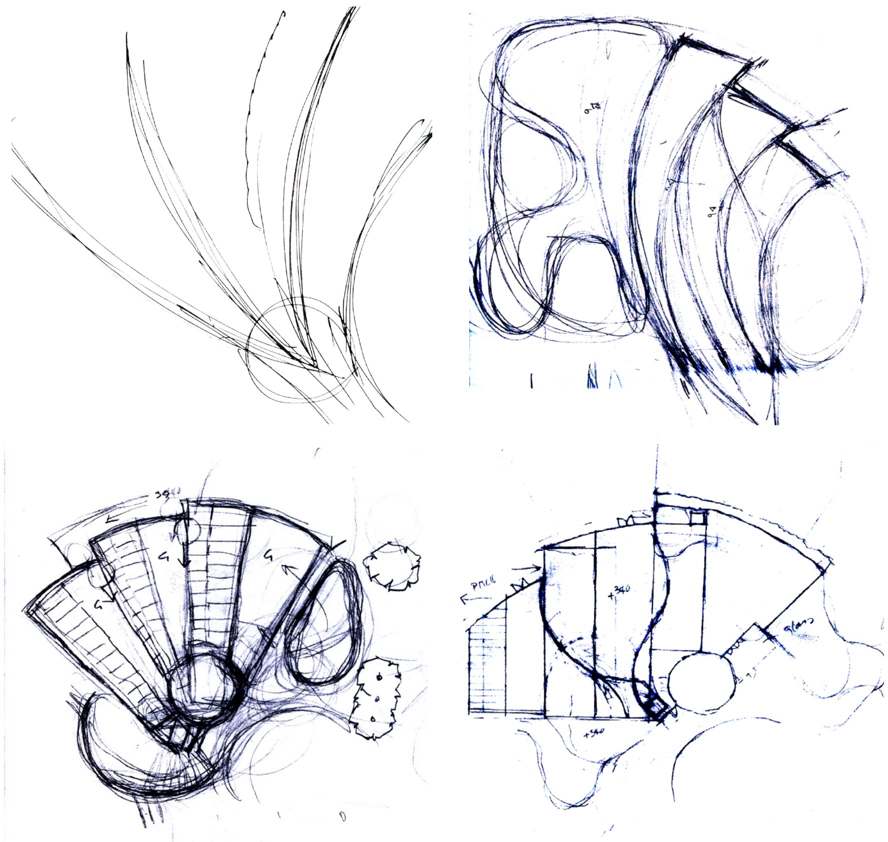


Figure 9.4. Concept Evolution

Design Narrative

This learning landscape begins with a regrading of the lower terrace from northeast to the southeast leading up to the building (Fig 9.5) This creates three relatively level working fields for research projects, demonstration gardens or garden competitions, or student projects that demand more space than can be accommodated within the building (Fig 9.6). These could be planted with seasonal crops such

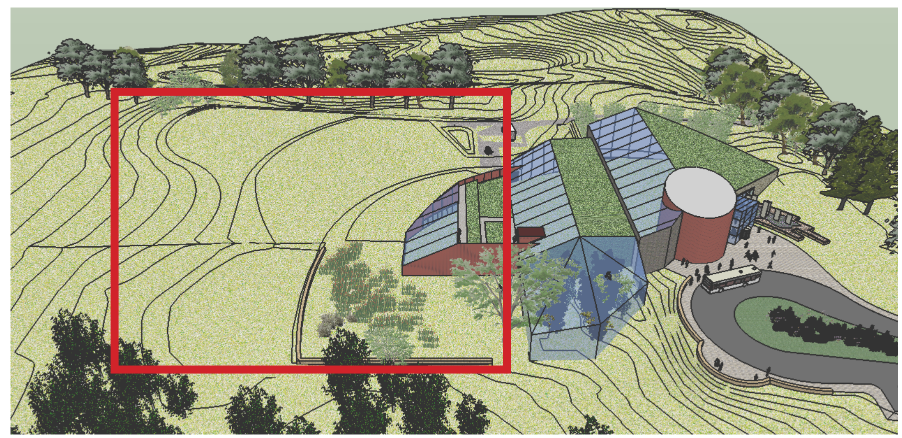
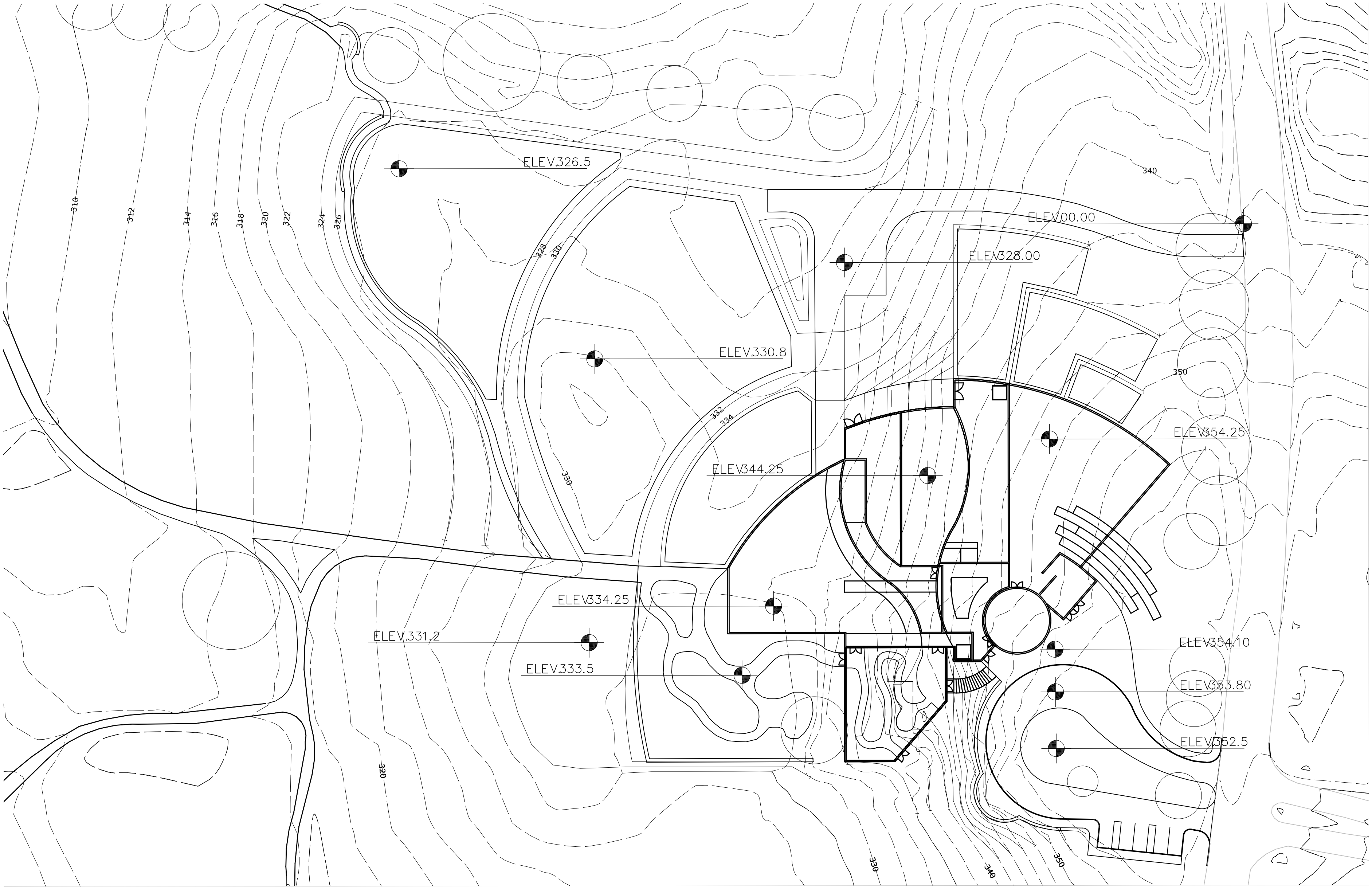


Figure 9.6. SketchUp model with a site view from south to north showing building features and regraded fields (red).

as winter rye and managed as hay fields when not actively being used, except for the upper field adjacent to the building which would best

Figure 9.5. Grading Plan.



be maintained with crushed stone over a porous base in order to facilitate outdoor projects such as retaining wall construction. The fields are separated by 4' grade changes along their perimeters.

Inside the building Level 1 is subdivided into spaces for offices, bulk material storage and workshops, and research areas that can be further subdivided for individual projects (Figure 9.7, Page 47). Public access is limited to this area is limited. The flooring system consists of a rigid pervious membrane over a reinforced galvanized grate that allows the collection and return of water used in stormwater experiments (Fig. 9.8). The water system is fed from a 30,000 gallon reservoir located on Level 2 that is supplied by building and road runoff. A similar plenum space is used for the Level 2 deck of the student studio. Level 1 indoor and outdoor spaces are separated by sliding shift doors with large glass or polycarbonate panels to facilitate a sense of connectivity (Fig. 9.9.).

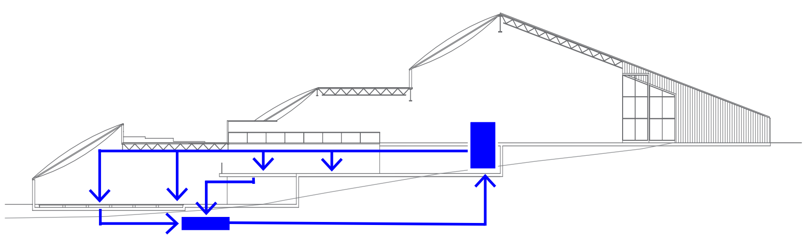


Figure 9.8. Schematic diagram showing the distribution and collection of stored water for stormwater exercises. Existing grade is also shown.

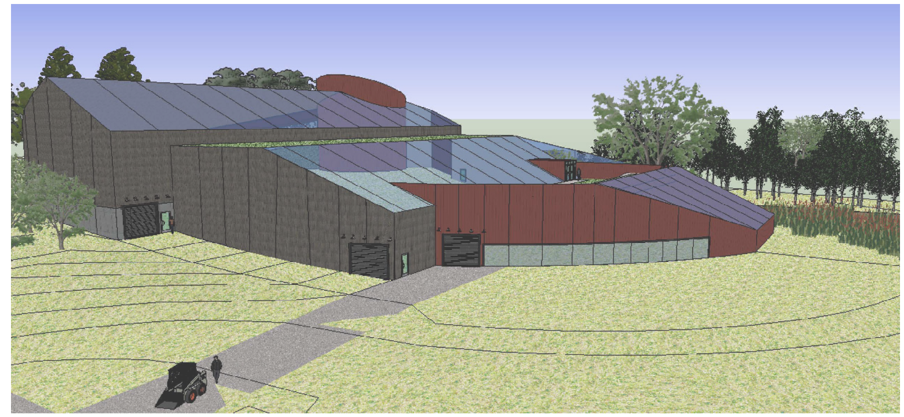
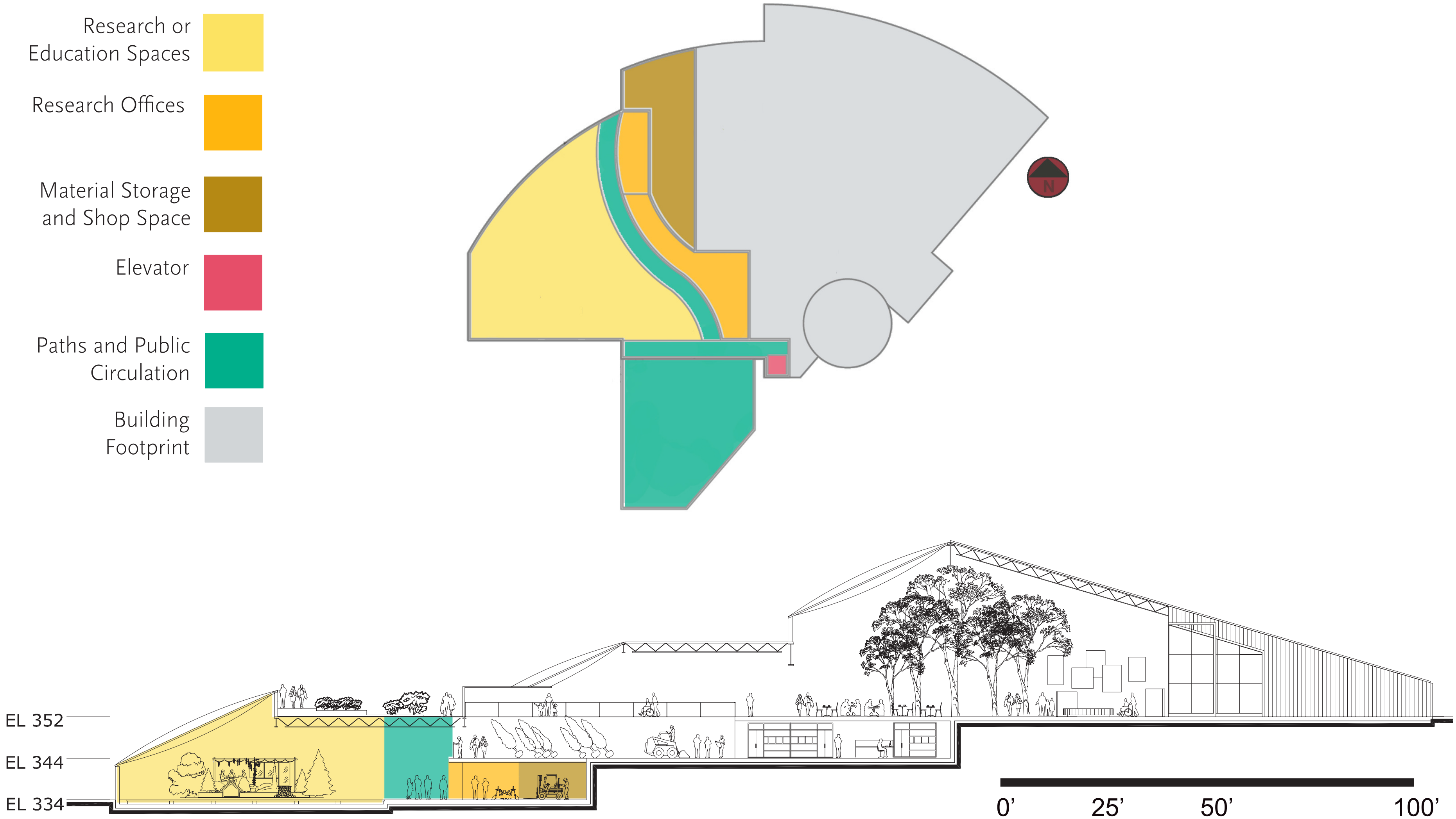


Figure 9.9. Level 1 translucent shift doors link interior and exterior spaces. Access to the service and storage areas are through utility doors located in the north side of the building.

On the south side of the building Level 1 opens to an enclosed greenhouse space housing a "Living Machine" for the treatment of building waste and an adjacent constructed wetland dedicated to the final phases of wastewater treatment. These areas are open to the public as education displays, rich in aquatic systems and plantings. The visitor paths connect to the Orchard Hill broader trail network.

Figure 9.7. Level 1 indoor spaces.



The floor elevation of Level 2 sits 10' above that of level 1 (Fig. 9.10 page 49). The Level 2 deck overlooks the area below and similar to Level 1 consists of open work space for student teaching and material exploration. Bulk material storage exists on the east side of the space under the Level 3 overhang. (Access to both the Level 2 and Level 1 storage spaces is by roll-up utility doors on the north side of the building). In addition, a materials library (modelled after Material Connexion www.materalconnexion.com) is located on the south side of the space where both students and the public can access its resources (Fig. 9.11). From Level 2 a visitor path meanders through the greenhouse space, connecting to Level 1 and the outdoor constructed wetland. As an alternative an elevator links all three levels.

Figure 9.11. Material Connexion, NY, NY houses a growing library of 3500 material samples for design applications. Source: www.materialconnexion.com

At Level 2 access is also provided to the ground floor of the teaching and lecture theater. A tunnel runs beneath the amphitheater-style seating for delivering palletized materials to the demonstration stage from the storage area. The floor in this space also contains a plenum for recapturing water used in presentations.

Level 3 is the primary public exhibition floor with an entrance and foyer facing East Pleasant Street (Figs. 9.12, 9.13). Visitors are greeted by an expansive water sculpture (linked to the water reservoir) that flows into the building through broad glass building panels. The curving form of the sculpture helps define the arrival space while its tall stone flags -- highly visible from the road -- symbolize the most basic, enduring and sustainable of materials found in the built environment. Once inside visitors find an expansive space suitable for permanent interpretive exhibits relating to the Waugh Arboretum, travelling exhibits and changing displays of student projects, as well as amenities that visitors to a botanical destination expect including a cafe', book and gift shop, information area, and handicapped compliant public rest room facilities (Fig 9.14).

Sitting 10' above Level 2, Level 3 overlooks both the student and research areas and provides a vista over an active learning landscape

Figure 9.10. Level 2 indoor spaces.

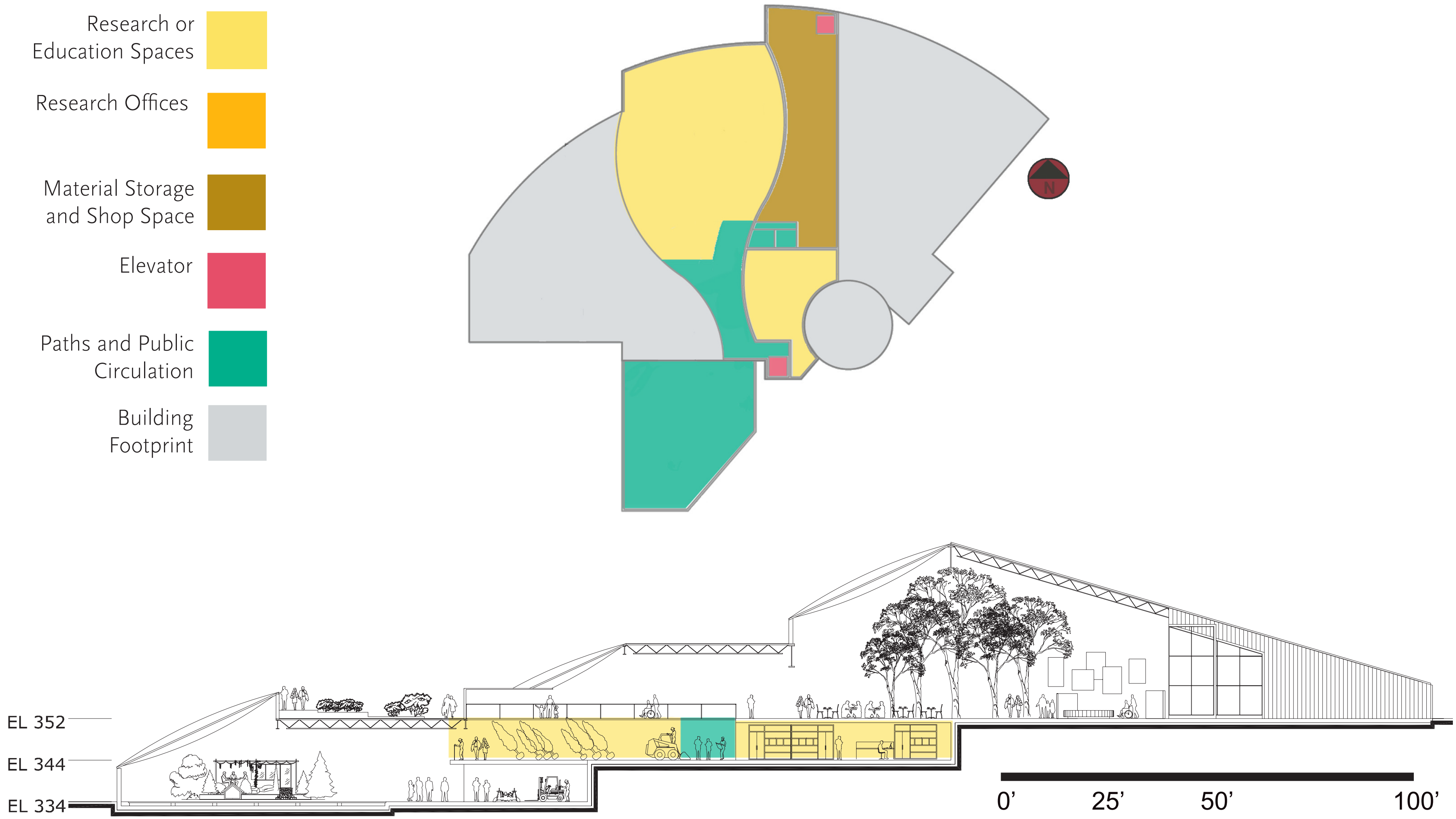
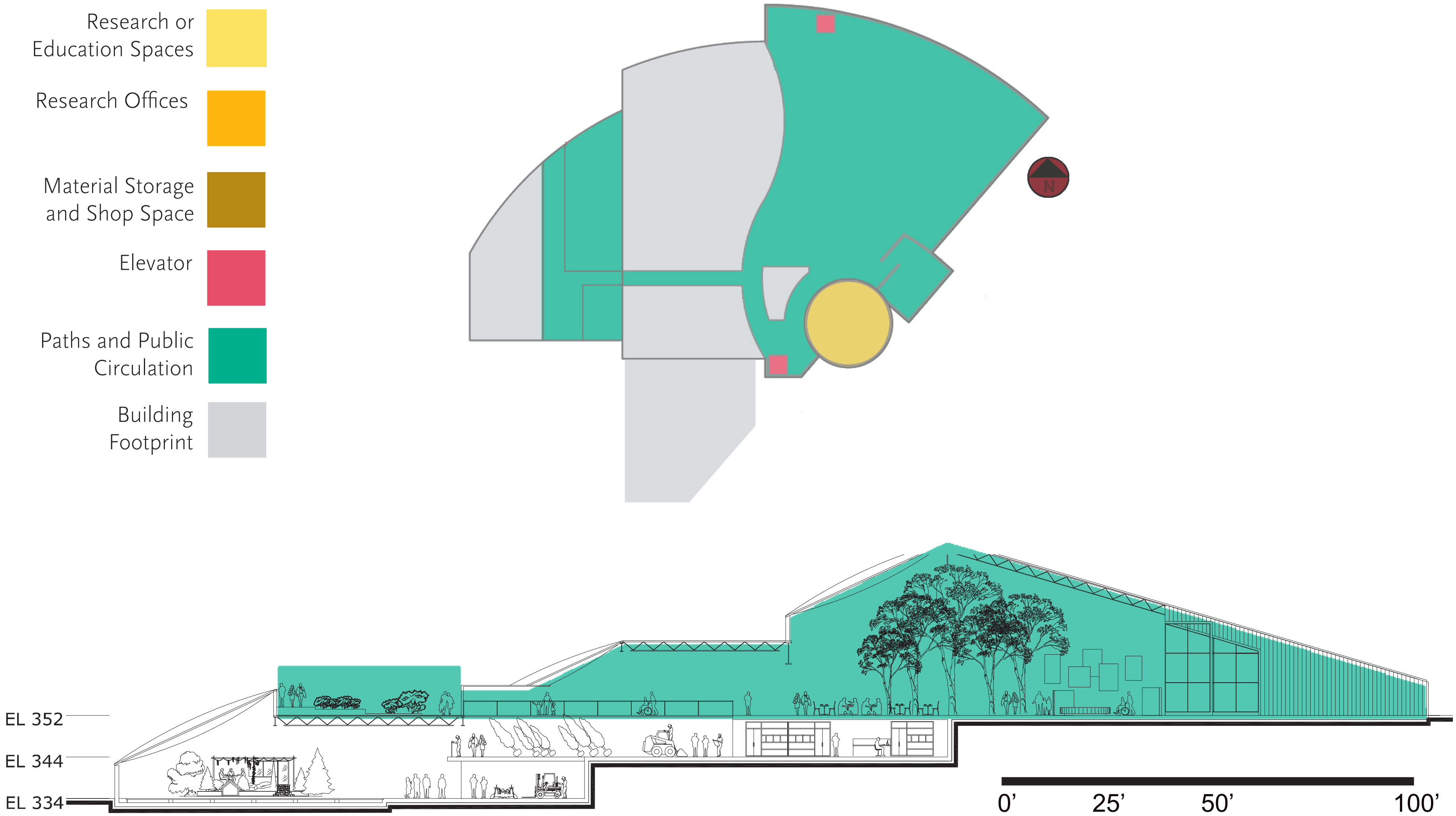


Figure 9.12. Level 3 indoor spaces and roof-top garden.



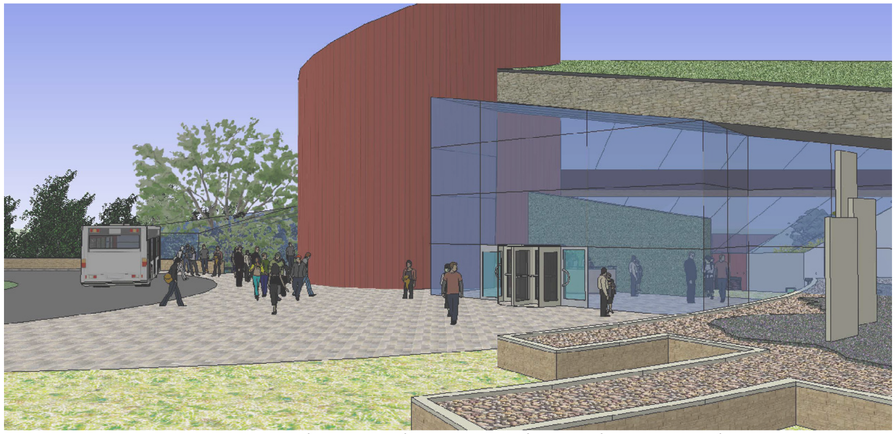


Figure 9.13. Entrance plaza with materials sculpture welcoming visitors.

(Fig 9.15). High ceilings and massive skylights above each level are conducive to indoor greenwall displays, seasonal plantings, and horticultural exhibitions. The skylights are made of argon filled

Figure 9.14. Level 3 visitor reception and exhibition space.

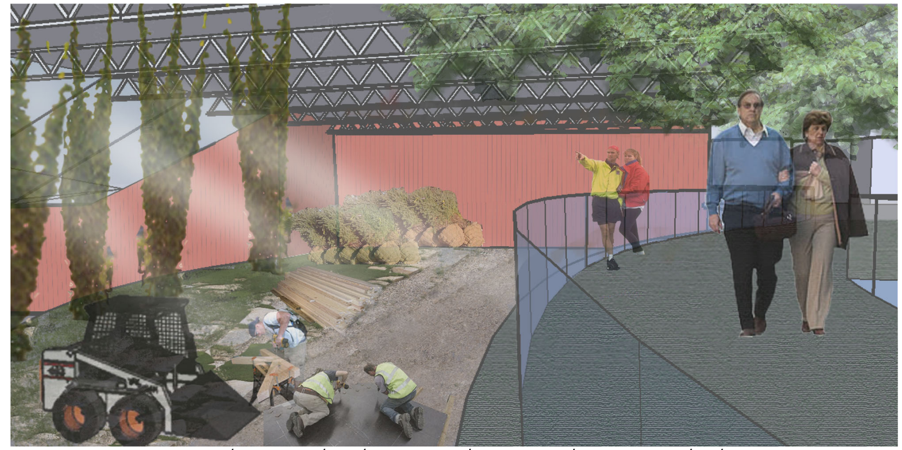


Figure 9.15. Level 3 overlook to student work spaces below.

pillows of recyclable ETFE providing good insulation at a fraction of the weight of glass and nearly 100% ultraviolet light transparency. Other sections of the roof utilize green-roof technology. Together they showcase two different approaches to state-of-the-art sustainable cladding and roofing systems. Both can be experienced up close as a pedestrian bridge extends from Level 3 to the exterior roof of Level 1 where visitors can explore the roof-top garden as well as enjoy vistas overlooking Orchard Hill to the south, west and north (Fig 9.16).

General access to the site is provided from East Pleasant Street. Visitors arrive on foot by crossing East Pleasant from the parking areas on Olympia Drive or by bicycle or bus from the drop off area

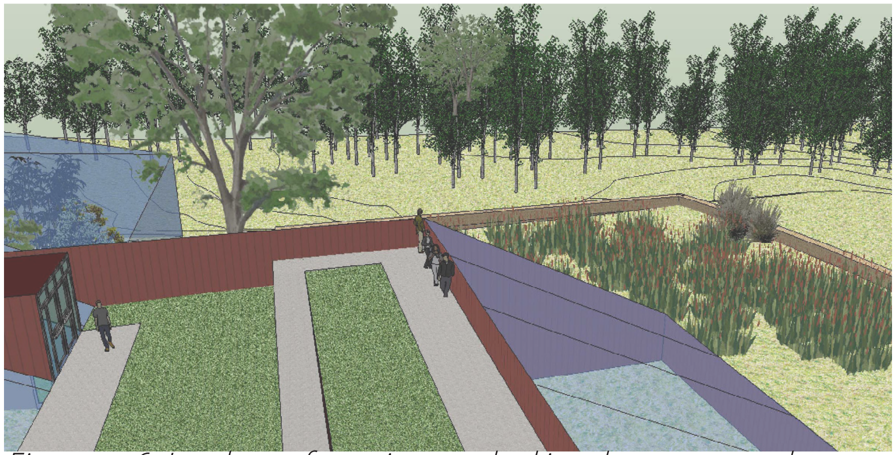
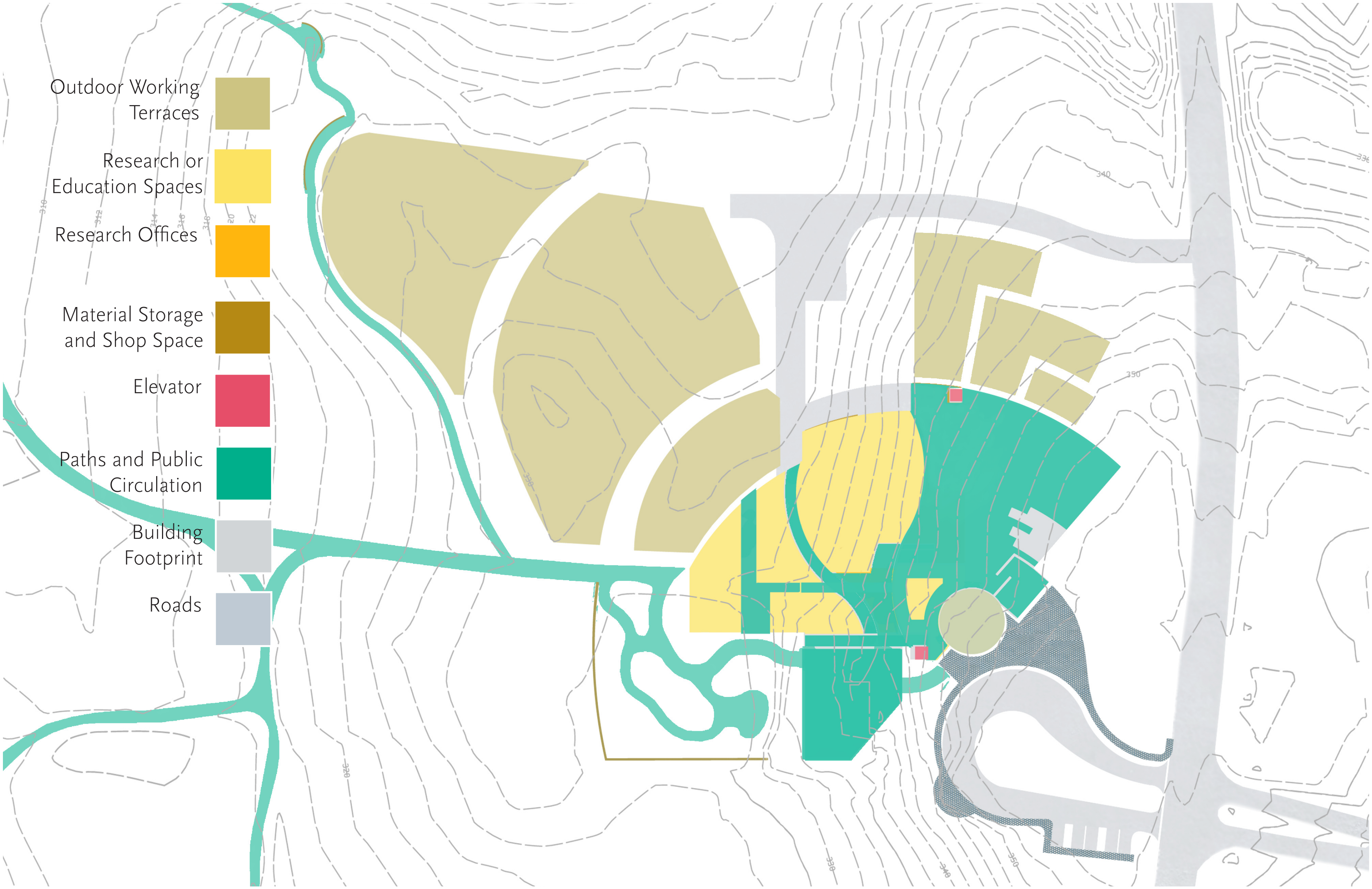


Figure 9.16. Level 1 roof top view overlooking the constructed wetland and natural wetland to the southwest.

on the east side of the building (Fig. 9.17). A service road from East Pleasant Street extends from street grade to the base of the slope, approximately 6' below the finished floor elevation at Level 1. Adequate room is provided for a tractor trailer to back into a receiving zone where bulk materials can be unloaded for transfer to storage areas. A ramp along the north side of the building covers the 10' of grade change between the Level 1 and Level 2 service doors. A freight elevator at Level 2 allows deliveries to Level 3 in support of cafe', exhibition, or event operations.

Figure 9.17. Level 1, Level 2 and Level 3 indoor and outdoor spaces. (Research offices and storage on Level 1 and Level 2 are hidden.)



CHAPTER 5 CONCLUSION

The concept for the Center for Exploration and Innovation in the Built Environment is multifaceted and its scope has broadened from the early vision. An initial goal was to develop the conceptual design for a space where students could learn hands-on skills working with traditional and contemporary landscape materials and researchers could explore new ways in which these materials could be used in landscape applications. To this end the facility itself was envisioned as a showcase for sustainable technology, examples of which are employed throughout the site (Fig. 10.1). A review of the current literature on sustainability revealed that boundaries between professional disciplines related to materials and the built environment are largely artificial and that an opportunity exists for students to understand sustainability through an integration of ecological, technological, and tectonic approaches. Thus we see that such a learning landscape has pedagogical value in many departments across the University of Massachusetts campus where the ability to teach and test field construction methods has application. Moreover, a brief study of informal learning environments having horticultural displays and

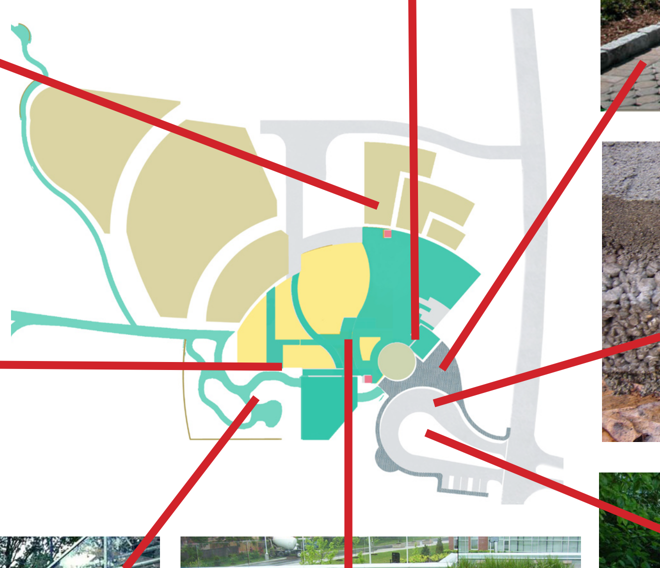
Fig. 10.1. Select materials and systems that promote sustainability in the built environment.

Indoor greenwall systems. Source: www.indoorlandscape.de

Ideal Aqua-Bric® permeable concrete pavers. Source:www.idealconcreteblock.com/photo_gallery/pavers/aqua_bric.html#

Rainwater-havesting and recirculating water systems. Source: www.remservices.co.uk

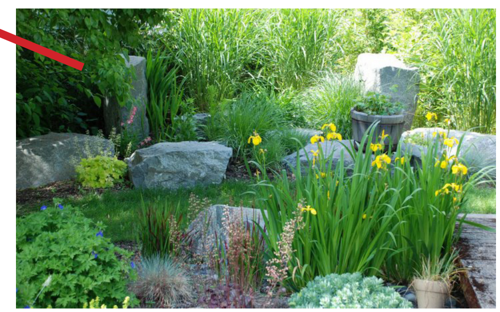
Passive solar trombe wall-heating system. Source: www.multiwallsystems.com



No fines pervious concrete paving. Source: www.percocrete.com

Living machine and constructed wetland for wastewater. Source: www.ecofriend.org

Intensive green roof system Source: www.eltgreenroofs.com



Raingarden with hydrophilic plantings. Source: www.picasaweb.google.com/plantgrl/LandscapePortfolio#

content shows the potential for engaging, informing, and motivating the public on issues associated with sustainability and a healthy environment. It is here where the interests of our communities, governments, educational institutions, and regional businesses overlap and where a basis for financial support may be built through creative program development, fund raising, and public-private partnership.

One example of such a partnership is between the Canadian landscape trades industry and the Olds College (Olds, Alberta CA) horticulture and landscape construction program. In 1997, Olds College opened their 12,000 square foot Landscape Construction Pavilion with support from the Bank of Montreal, the Landscape Alberta Nursery Trades Association and members of the horticulture industry. The Pavilion was constructed in response to industry requests for Olds College to provide students with greater opportunities to develop hands-on horticultural skills and is currently undergoing expansion. Additional uses include industry training and certification programs such as the Certified Horticulture Technician (CHT) and the Utility Tree Worker (see www.oldscollege.ca/campus/landscape_pavilion.htm).

Given such opportunities it would be tempting to view this project primarily through the lens of its utilitarian value in promoting landscape and building technology. This, however, would be shortsighted. Returning to the work of Margolis and Robinson (2007), McDonough and Braungart (2004) and others reminds us that we are in the midst of a material revolution that can have profound effects on the way we view the built environment as a whole.

A broader view would be of a place where earth, water, structure (including new technology), and plants can be brought together in ways that break down traditional thinking about indoor and outdoor spaces, resource use, and the life cycles of products. Where researchers can innovate, where students can explore, and where people can experience the art and science of the built environment (Fig. 10.2). The University of Massachusetts, with its demonstrated commitment to green design and construction, community outreach, and academic excellence, is well positioned to advance a sustainable future through the Center for Innovation and Exploration in the Built Environment.

Figure 10.2. Inspiring examples of innovation in materials and the built environment.

Source: www.earthfirst.com

Source: www.bustler.net

Source: www. livingsystemsla.blogspot.com

Source: www.bustler.net

Source: www.livingsystemsla.blogspot.com

Source: www.bustler.net

Adams, W. M. 2006. The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century. Report of the IUCN Renowned Thinkers Meeting, 29-31 January 2006, 18 pp.

Ahern, J., Lindhult, M. and J. Mullin. 1993. Campus Physical Master Plan University of Massachusetts, Amherst. University of Massachusetts. 56 pp.

Brundtland Commission. 1987. Our Common Future: The Report of the Brundtland Commission, Oxford University Press, Oxford, NY. 400 pp.

Californian Integrated Waste Management Board. 2004. Living and Learning Sustainability at the Center for Regenerative Studies. California Integrated Waste Management Board Summary Fact Sheet, May 2004. 2 pp.

Carpenter, W. J. 1997. Learning by Building: Design and Construction in Architectural Education. Van Nostrand Reinhold, New York. 180 pp.

Dreiseitl, H., Grau, D. and K. H. C. Ludwig. 2001. Waterscapes. Birkhauser, 176 pp.

Dreiseitl, H. and D. Grau. 2006. New Waterscapes. Birkhauser Basel. 176 pp.

Hayes, R. W. and R. A. M. Stern. 2007. The Yale Building Project: The First Forty Years. Yale University Press, New Haven, CT. 272 pp.

Hays, K. M. and D. Miller (eds.). 2008. Buckminster Fuller: Starting with the Universe. Yales University Press, New Haven. 272 pp.

Heerwagen, J. and B. Haas. 2001. Building biophilia: Connecting people to nature. Environmental Design + Construction 2001(3):33.

Hinson, D. 2007. Design as research; learning from doing in the design-build studio. Journal of Architectural Education 21(1):23-26.

Kellert, S. 2005. Building for Life: Designing and Understanding the Human-Nature Connection. Island Press, Washington DC. 250 pp.

Kibert, C. 2005. Sustainable Construction; Green Building Design and Delivery (2nd ed.) John Wiley & Sons, New York. 434 pp.

Kibert, C. J., Senzimer, J., and B. Guy. 2000. Construction ecology: natural systems models for the built environment. Proceedings: Strategies for a Sustainable Built Environment, Pretoria, 23-25 August, 2000. Pp. 1-5.

Kirkwood, N. 1999. The Art of Landscape Detail. John Wiley & Sons, New York. 352 pp.

McDonough, W. and M. Braungart. 2004. Cradle to Cradle: Remaking the Way We Make Things. North Point Press, New York.

Lindhult, M. and J. Ahern. 1995a. Landscape for Learning: A Plan for Enhancing the Physical and Visual Quality of the Campus. University of Massachusetts, Amherst. 40 pp.

Lindhult, M. and J. Ahern. 1995b. North Area Plan. University of Massachusetts, Amherst. 32 pp.

______________________. 1997. East Area Plan. University of Massachusetts, Amherst. 51 pp.

______________________. 1998. Northeast Area Plan. University of Massachusetts, Amherst. 32 pp.

Margolis, L. and A. Robinson. 2007. Living Systems: Innovative Materials and Technologies for Landscape Architecture. Birkhauser Basel. 191 pp.

McHarg, I. L. 1969. Design with Nature. Natural History Press, New York. 198 pp.

Mossop, E. 2006. Landscapes of Infrastructure. In: The Landscape Urbanism Reader, C. Waldheim, (ed.), Princeton Architectural Press, NY. Pp. 163-177.

Meyers, E. 2008. Sustaining beauty; the performance of appearance. Landscape Architecture 98(10):92-131. (Reprinted from Journal of Landscape Architecture, Spring 2008.)

Nassauer, J. I. 1995. Messy ecosystems, orderly frames. Landscape Journal 14(2):161-170.

Orr, D. W. 2004. Can educational institutions learn? The creation of the Adam Joseph Lewis Center at Oberlin College. Pp. 159-175 In: Sustainability on Campus: Stories and Strategies for Change, P. F. Bartlett and G. W. Chase (eds.). The MIT Press, Cambridge, MA.

Postel, S. L., Dailey, G. C., and P. R. Erhlich. 1996. Human appropriation of renewable freshwater. Science 271:785-788.

Robinson, L. A. 2005. Structural Opportunities of ETFE (ethylene tetra fluoro ethylene). Master's Thesis submitted to the Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, Cambridge, MA. 66 pp.

Rose, J. 1939. Plant forms and space; materials create volume by definition of space. Pencil Points 20:226-230.

Roseen, R., Ballestro, T. and J. Houle. 2007. University of Hampshire Stormwater Management Center Annual Report. University of New Hampshire, Durham, NH. 36 pp.

Stairs, D. 1997. Biophilia and technophilia: examining the nature/culture split in design theory. Design Issues 13(3):37-44.

Telegen, J. 2005. Sustainable Design in Massachusetts: Obstacles and Opportunities. Masters Thesis, Urban and Environmental Policy and Planning, Tufts University, Boston, MA. 131 pp.

The Eden Project. 2008. The Eden Project Annual Review 2007/2008. The Eden Project, Cornwall, England. 23 pp.

Thompson, J. W. and K. Sorvig. 2008. Sustainable Landscape Construction: A Guide to Green Building Outdoors (Second Edition). Island Press, Washington, D.C. 381 pp.

Todd, N. J. 2005. A Safe and Sustainable World: The Promise of Ecological Design. Island Press, Washington, D.C. 224 pp.

United Nations Department of Economic and Social Affairs. 2007. World Population Propects; The 2006 Revision (Executive Summary). United Nations, New York, NY. 21 pp.

Utt, R. D. 2005. Public/Private Partnerships Offer Innovative Opportunities for School Facilities. Maryland Public Policy Institute, Germantown. MD. 25 pp.

Van der Ryn, S. and S. Cowan. 2007. Ecological Design (10th Anniversary Edition). Island Press, Washington, D.C. 256 pp.

Vitousek, P. M., Mooney, H. A., Lubchenco, J. and J. M. Melillo. 1997. Human domination of Earth's ecosystems. Science 277:494-499.

Winterbottom, D. 2002. Building as a model for learning. Landscape Journal 21(1-02):201-213.

Appendix A; Massachusetts Professional Landscape Associations

Ecological Landscaping Association

The Ecological Landscaping Association (Framingham, MA) is a nonprofit, member-based organization of landscape professionals, homeowners, and community groups who believe in using landscape practices that are environmentally safe and beneficial.

Massachusetts Association of Landscape Professionals

The Massachusetts Association of Landscape Professionals (MLP) (South Natick, MA), formerly ALCM, is the only non-profit professional trade association in Massachusetts specifically created to serve the landscape management industry. Its membership includes landscape management contractors, design/build installation contractors, lawn care professionals and other allied green industry professionals.

Massachusetts Arborists Association

The Massachusetts Arborists Association (MAA) and the Massachusetts Certified Arborists (MCA) program (South Natick, MA) are the cornerstones of the state's professional tree care industry serving the consumers of Massachusetts with reliable and sustainable tree care.

Massachusetts Nursery & Landscape Association

The Massachusetts Nursery & Landscape Association (Conway, MA) is a volunteer, nonprofit organization whose members are businesses and individuals involved in the production, sale, and handling of nursery stock in Massachusetts and working to promote the environmental well being of our state as well as the highest levels of business ethics within their profession.

Appendix B; Undergraduate "Living Laboratory" Courses at California Polytechnic University at Pomona

Each year, the Center offers a series of living laboratory courses on current applications in regenerative studies (RS 414/414L). These courses emphasize "hands on" application of regenerative principles and practices, and topics will change quarterly. RS 414/414L course numbers can be repeated for a total of 12 units.

Living laboratory courses for 2008-09 include:

RS 414/414L: Current Applications in Regenerative Studies: Regenerative Landscape Construction Processes. 4 units. (Class Nbr 73420/73421) Doug Kent, Instructor

This course is intended specifically for students planning to work with built landscapes. It covers the basics of Regenerative landscape construction, including defining a Regenerative landscape, properly protecting a site, alternative materials, ecological cost estimation, low-impact construction techniques, constructing water capture systems, such as greywater and wetlands, maintenance, and deconstruction.

RS 414/414L: Current Applications in Regenerative Studies: Phytoremediation and Bioremediation of Degraded Sites. 4 units. Dr. Hossein Ahmadzadeh and Dr. Stephen Lyon, Instructors

This "living lab" course provides an understanding of the processes involved in phytoremediation and bioremediation, i.e. the use of plants and their associated microbes and bacterial/fungal communities in soils to remediate environmental pollution in brownfields and other degraded sites. Students will know which technologies are used in which cases, and why. They will be given an overview of basic environmental chemistry, soil science and the biological mechanisms involved in pollutant uptake, accumulation and transformation and degradation.

RS 414/414L: Current Applications in Regenerative Studies: Solar Energy Systems. 4 units Dr. Charles Ritz, Instructor

The course covers the fundamentals of solar energy generation. Students will examine a variety of solar technologies to better understand their operation, feasibility, cost effectiveness and maintenance. The course includes a "hands on" lab component.

RS 400. Directed Study in Regenerative Practices. 2-4 units.

Individual study by the student on a subject agreed upon by student and advisor. Total credit limited to 4 units, with a maximum of 2 units per quarter. Prerequisites: RS 301 and 302 or permission of instructor. Approval of study proposal must be granted before enrollment. Contact the program advisor for more information.

RS 465. Ecological Patterns and Processes. 4 units.

This course introduces students to principles in the emerging field of landscape ecology, and their relationship to planning and design decisions upon the land. Students will learn about the intellectual roots of this approach to understanding landscape patterns and processes, the fundamental vocabulary and key concepts within the field, and their relationship towards the goal of increased environmental sustainability.

RS 499/499L. Special Topics in Regenerative Practices. 2-4 units.

Exploration of topics of current interest related to regenerative practices or technologies or their roles in society. May include lectures, seminars and/or laboratories on a schedule to be determined by the instructor. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite RS 301 or RS 311 or permission of instructor.